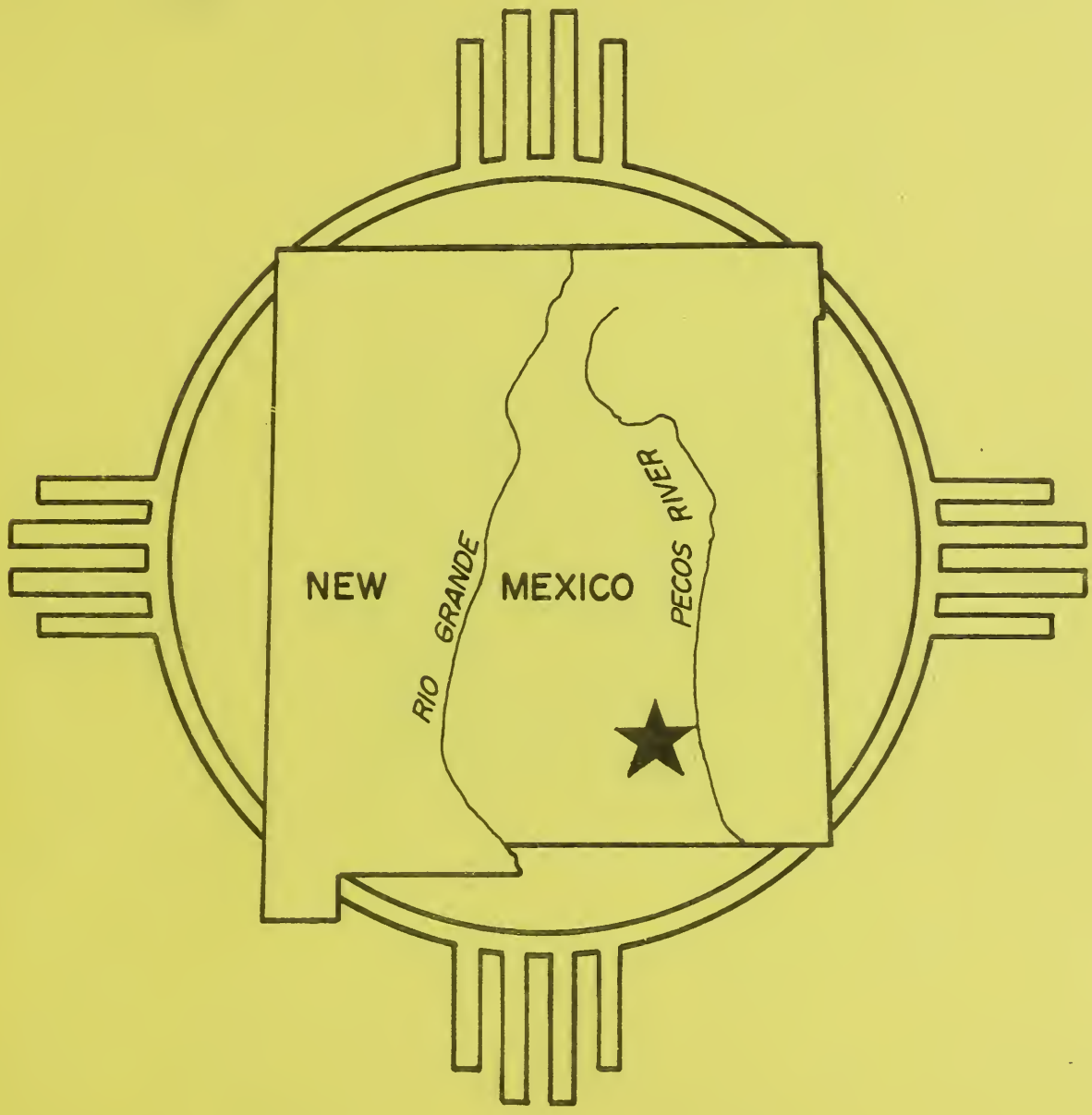
WATERSHED WORK PLAN

COTTONWOOD-WALNUT CREEK WATERSHED



CHAVES & EDDY COUNTIES

NEW MEXICO

June 1975

Prepared under the authority of the Watershed Protection & Flood Prevention Act (Public law 566, 83rd Congress, 68 Stat. 666) as amended.

ADDENDUM

JUNE 1975

WATERSHED WORK PLAN
Cottonwood-Walnut Creek Watershed

Chaves and Eddy Counties
New Mexico

CONTENTS

INTRODUCTION

This addendum is based on the Water Resources Council's Principles and Standards for resource planning.

The work plan for the Cottonwood-Walnut Creek Watershed was developed using 1975 construction costs, current normalized agricultural prices, current non-agricultural prices, and 5-7/8 percent discount rate. The values for recreation in the work plan are those established under Senate Document 97.

Effects and impacts resulting from the selected work plan alternative are displayed under separate accounts for National Economic Development, Environmental Quality, Regional Development and Social Well-Being.

The abbreviated environmental quality plan has been developed by using information and data prepared and assembled during investigations and analyses for the watershed work plan. The development of the abbreviated environmental quality plan begins with a recognition of the watershed problems and needs. Component needs to improve the environmental quality were developed and opportunities or options to remedy or solve the needs determined.

These options were translated into specific plan elements. The estimated preliminary cost of the environmental plan is $13,200,000. The expected environmental effects and impacts of the environmental quality plan are shown.

Part 1 of the Addendum shows the effect of 6-1/8 percent interest rate on benefits and costs of the selected plan.

PART 1

This part of the addendum shows estimated project costs, benefits, and the benefit-cost ratio for the selected plan based on *6-1/8* percent interest rate for 100 years.

Current normalized prices and 1975 construction costs were used.

The average annual costs, average annual benefits, and the benefit-cost ratio for the selected plan at *6-1/8* percent interest are as follows:

1.	Project costs	$682,200
2.	Project benefits	773,900
3.	Benefit-cost ratio	1.1:1
4.	Benefit-cost ratio without secondary benefits	1.0:1

SELECTED PLAN
NATIONAL ECONOMIC DEVELOPMENT ACCOUNT
Cottonwood-Walnut Creek Watershed, New Mexico

Components	Measure of Effects 1/ (Dollars)
Beneficial Effects:	
The value to users of increased output of goods and services.	
1. Flood prevention	463,400
2. Recreation	98,100
3. Utilization of unemployed and under-employed labor resources:	
Project construction and OM&R	148,700
Total beneficial effects	710,200

Components	Measure of Effects 1/ (Dollars)
Adverse Effects:	
The value of resources required for the plan.	
1. Floodwater retarding structures, floodwater diversions, channels, one multiple-purpose structure with basic recreation facilities.	
Project installation	518,900
Project administration	58,800
OM&R	80,400
Total adverse effects	658,100
Net beneficial effects . . .	52,100

1/ Average annual.

SELECTED PLAN
ENVIRONMENTAL QUALITY ACCOUNT
Cottonwood-Walnut Creek Watershed, New Mexico

Components	Measure of Effects
Beneficial and adverse effects:	
A. Areas of natural beauty	1. Reduction of flood damage will permit 50 owners on about 6,000 acres of agricultural land to improve and maintain visual quality of the landscape.
	2. Prevention of flood damage to 630 acres of urban land in north Artesia will allow the owners of 100 homes and 10 business properties to improve and maintain the visual quality of the environment and provide a more pleasing area in which to live and work.
	3. Reduced peak flows on about 7 miles of Cottonwood and Walnut Creeks below structures will improve conditions for increased vegetative growth and wildlife habitat over a period of time.
B. Quality Consideration of Water, Land and Air Resources	1. The reduction of sediment deposition in the floodplain or damage areas will decrease the amount of dust in the air from wind and the movement of vehicles on the roads.
	2. Reduction of sediment entering the Pecos River by about 10,220 tons per year, thereby improving to some extent the quality of water below the watershed.
	3. Air and water pollution will temporarily be increased to some extent during project construction.
	4. Reduction of the concentration of sediment in water from the watershed to the Pecos River from 9,136 to 5,012 milligrams per liter.
	5. Loss of about 750 acre-feet of water annually by evaporation.

SELECTED PLAN
ENVIRONMENTAL QUALITY ACCOUNT
Cottonwood-Walnut Creek Watershed, New Mexico

Components	Measure of Effects
C. Biological resources and selected ecological systems	1. An average of 120 acres of water surface at Site 19 will create additional fish and wildlife habitat.
	2. Temporarily lower the quality of wildlife habitat on about 6,000 feet of existing channels during and following construction.
	3. Approximately 300 acres of high quality wildlife habitat will be damaged in floodwater retarding Sites 4, 6, 7, 8 and the multi-purpose structure Site 19 during construction. Some of this loss of wildlife habitat will be offset by increased vegetative growth around the perimeter of the detention pools of the floodwater retarding structures.
D. Irreversible or irretrievable commitment of resources	1. About 7,645 acres of agricultural land will be committed to dams, reservoirs, spillways, channels, floodwater diversions, and recreation facilities. Rangeland constitutes 7,445 acres of the total land lost for agricultural production which produces on the average about 100 animal units of grazing per year. About 200 acres of irrigated cropland will be removed from agricultural use by the project.
	2. Grazing use on about 2,400 acres of land will be intermittently interrupted by flooding in the detention pools of the floodwater retarding structures and along floodwater diversions.
	3. Disturb and destroy cultural sites.

SELECTED PLAN
REGIONAL DEVELOPMENT ACCOUNT
Cottonwood-Walnut Creek Watershed, New Mexico

Components	Measure of Effects 1/ State of N.Mexico	Rest of Nation
	- - - Dollars - - -	
A. Income:		
Beneficial effects:		
1. The value of increased output of goods and services to users residing in the region.		
a. Flood Prevention	463,400	-
b. Recreation	98,100	-
c. The utilization of unemployed and under-employed labor resources:		
Project Construction, OM&R	148,700	-
2. The value of output to users residing in the region from external economies		
a. Induced by and stemming from project installation and OM&R	57,700	-
Total Beneficial Effects:	767,900	-

Components	Measure of Effects 1/ State of N.Mexico	Rest of Nation
	- - - Dollars - - -	
A. Income:		
Adverse effects:		
1. The value of resources contributed from within the region to achieve the outputs.		
a. Floodwater retarding structure, floodwater diversions, channels, Site 19 - MP structure		
Project Installation	18,500	432,100
OM&R	45,100	-
b. Recreation reservoir and basic facilities:		
Project Installation	45,200	23,100
OM&R	35,300	-
c. Project Administration	500	58,300
Total Adverse Effects:	144,600	513,500
Net Beneficial Effects:	623,300	144,600

1/ Average Annual.

SELECTED PLAN
REGIONAL DEVELOPMENT ACCOUNT (Continued)
Cottonwood-Walnut Creek Watershed, New Mexico
1/

Components	Measure of Effects	
	State of N.Mexico	Rest of Nation
	- - - Dollars - - -	
Employment:		
Beneficial effects:		
A. Increase in number and types of jobs		
1. Employment for project construction	25 semi-skilled jobs over 8-year installation period	-
2. Employment for project OM&R	Three permanent semi-skilled jobs.	-
Total Beneficial Effects:	25 semi-skilled jobs over the installation period of 8 years. Three permanent semi-skilled jobs.	-

Components	Measure of Effects	
	State of N.Mexico	Rest of Nation
	- - - Dollars - - -	
Employment:		
Adverse effects:		
A. Decrease in number and types of jobs	0	0
Total adverse effects	0	0
Net beneficial effects	25 semi-skilled jobs over project installation period of 8 years. Three permanent semi-skilled jobs.	

SELECTED PLAN
REGIONAL DEVELOPMENT ACCOUNT (Continued)
Cottonwood-Walnut Creek Watershed, New Mexico

Components	Measure of Effects	
	State of N.Mexico	Rest of Nation
	- - - Dollars - - -	
Regional Economic Base and Stability		
Beneficial effects:	The selected project will provide flood protection from a 1 percent chance of occurrence flood to 100 homes and 10 business properties in the north part of Artesia. About 6,000 acres of irrigated land will be protected from flood damage, thereby stabilizing the agricultural production and family income for 50 families. The project will create jobs for 25 semi-skilled workers during the project installation and 3 permanent semi-skilled jobs for operation and maintenance of the project measures.	
Adverse effects:	-	-

SELECTED PLAN
SOCIAL WELL-BEING ACCOUNT
Cottonwood-Walnut Creek Watershed, New Mexico

Components	Measures of Effects
Beneficial and Adverse Effects:	
A. Real Income Distribution	1. Create 25 man-years of semi-skilled jobs annually over the project installation period of 8 years and 3 permanent semi-skilled jobs annually for operation and maintenance of the project.
	2. Create regional income distribution of $767,900 1/ by income class as follows:

Income Class ---Dollars---	Percentage of Gross Income by Class	Percentage of Income Benefits in Class	Percentage Benefits by Class
Less than 3,000	8	8	3	3
3000 to 10,000	40	40	27	27
More than 10,000	52	52	70	70

	3. Local cost to be borne by region totals $144,600 1/ with distribution by income class as follows:

Income Class ---Dollars---	Percentage of Gross Income by Class	Percentage of Income Contribution in Class	Percentage Contribution by Class
Less than 3,000	8	8	0	0
3000 to 10,000	40	40	30	30
More than 10,000	52	52	70	70

1/ Average Annual

SELECTED PLAN
SOCIAL WELL-BEING ACCOUNT (Continued)
Cottonwood-Walnut Creek Watershed, New Mexico

Components	Measure of Effects
B. Life, health, and safety	1. Provide flood protection from the 1 percent chance of occurrence flood to 100 homes and 10 business establishments in a 630-acre urban area in the north part of Artesia and to about 6,000 acres of agricultural land and 50 farm families. Future inconveniences and displacement during floods will be eliminated.
C. Recreational opportunities	1. Provide needed water-based recreation in the watershed and nearby areas. The recreation development will provide an estimated 63,970 recreation visits annually for fishing, hunting, boating, camping and picnicking.

PART 3

ABBREVIATED ENVIRONMENTAL QUALITY PLAN
Cottonwood-Walnut Creek Watershed, New Mexico

The goals for this environmental quality plan for the Cottonwood-Walnut Creek Watershed are to enhance and improve areas of natural beauty; improve and maintain the quality of land, water, and air; preserve and enhance the biological and ecosystems; and protect and preserve archeological and historical resources.

The principal environmental quality problems are deterioration of watershed lands from wind and water erosion, continuing loss of woody vegetation along natural channels or drainages for wildlife habitat, lack of winter vegetative cover for wildlife, periodic threat of flooding, inadequate vegetative cover on rangeland, and lack of open green space and parks.

The watershed is located in an open rural setting and is characterized by rolling topography in the upper end of the watershed. This area is rangeland. The mid and lower reaches of the watershed are gently sloping valley bottoms which have generally been developed into irrigated cropland. The native vegetation on the upper range areas, prior to deterioration due to past overuse in some instances, was black grama, blue grama, and sideoats grama grasses. Invading species after deterioration of the upland range sites are burro-grass and creosotebush. Climax vegetation on the bottom land range sites consists of alkali sacaton, giant sacaton, and vine mesquite grasses. With deterioration of the bottom land range sites invading species include tobosa grass, catclaw, saltcedar and mesquite brush.

Lack of adequate water supplies on portions of the rangeland creates problems in the distribution of livestock for proper range use and limits watering places for wildlife.

Periodic flooding of floodplain lands damages or destroys existing natural vegetation which provides food and cover for wildlife. Flooding also damages land, crops, farm improvements, built-up urban areas near the watershed, roads, and destroys wildlife and livestock.

Until recently no archeological studies had been made in the watershed. A preliminary field investigation and report by the Museum of New Mexico has identified several archeological and historical sites on which they recommend further investigation and possible salvage.

Component needs for solving the significant environmental problems in the watershed are listed below:

1. Areas of Natural Beauty

   a. Reduce wind and water erosion.
   b. Restore vegetation on denuded areas.
   c. Reduce loss of natural vegetation along Cottonwood and Walnut Creeks.
   d. Provide open green spaces or parks in the watershed.

2. Quality of Water, Land, and Air Resources

   a. Improve the quality of the ephemeral streamflow on Cottonwood and Walnut Creeks.
   b. Protect and maintain the land resource base by reducing gully and sheet erosion and floodplain scouring.
   c. Maintain and improve the productivity of the land resource base.
   d. Reduce flooding of agricultural lands in the watershed and nonagricultural lands adjacent to the watershed.
   e. Reduce sediment deposition.
   f. Reduce pollution of water from sediment.
   g. Reduce dust pollution in the air resulting from wind erosion.

3. Biological Resources and Ecosystems

   a. Preserve and improve wildlife habitat throughout the watershed by:

      (1) providing additional winter cover for pheasant, quail, dove, several species of songbirds, and small mammals.
      (2) reducing damage to existing wildlife habitat from flooding and from grazing by livestock.
      (3) creating additional watering places, food, and cover for wildlife.
      (4) creating additional water impoundment for fish, waterfowl and other wildlife.

4. Archeological and Historical Resources

   Locate, investigate and protect all of the important archeological and historical sites to prevent further damage to the sites from agricultural or other development activities and from artifact hunters.

The plan elements for maintaining, protecting, and improving the quality of the environment consist of land management, land treatment, structural measures, and site protection or salvage of archeological material.

Treatment on rangeland consists of grazing management systems to improve and restore the more desirable forage plants. This includes deferred grazing and proper grazing use. Needed water developments for livestock and wildlife include water wells, pipelines, tanks, and troughs. Fencing large areas into separate pastures will assist in implementation of improved grazing systems. Approximately 180,000 acres of rangeland remain to be treated.

Treatment on irrigated cropland consists of measures which will improve the application of water to the land and thereby reduce losses to beneficial use. Treatment measures which will conserve and save water include land leveling and the improvement of irrigation water delivery systems by installation of concrete ditches and irrigation pipeline. Conservation cropping systems and cover crops on the irrigated cropland to reduce wind and water erosion and provide cover and food for wildlife are elements of the plan. The planting of farm windbreaks in selected areas to reduce wind erosion and provide cover and food for tree nesting birds and for other wildlife is needed. The planting of selected tree vegetation along Cottonwood and Walnut Creeks to provide additional wildlife habitat is included in the environmental quality plan.

Landowners and operators are to be encouraged to apply and maintain land management and land treatment measures by the local natural resource conservation districts. Technical assistance is available from the Soil Conservation Service for planning and applying land treatment. Financial assistance, usually on a cost-share basis, is available through the Rural Environmental Conservation program and the Great Plains Conservation program.

Structural measures include the installation of ten floodwater retarding structures and five diversions on Cottonwood Creek and its tributaries. The structural measures for Walnut Creek and its tributaries include four floodwater retarding structures and two floodwater diversions. The floodwater detention pools in the 14 floodwater retarding structures and the seven floodwater diversions would be fenced.

The estimated installation cost of the elements of the environmental quality plan is as follows:

1.	Application of land treatment systems and land treatment measures	$2,500,000
2.	Installation of 14 floodwater retarding structures and 7 floodwater diversions	$7,500,000

3. Installation of one multi-purpose structure for flood prevention, wildlife and recreation with associated basic facilities and 50 acres of park . . . . . $ 3,000,000

4. Fencing and vegetative plantings along suitable areas of Cottonwood and Walnut Creeks . . . . . $ 75,000

5. Fencing the floodwater detention pools of floodwater retarding structures and the floodwater diversions . . . . . $ 75,000

6. Archeological investigations, salvage and site protection . . . . . $ 50,000

7. Estimated TOTAL COST of Environmental Quality Plan $13,200,000

The environmental effects that would result from the installation and maintenance of the environmental quality plan are as follows:

1. Areas of Natural Beauty

   a. Enhance and improve the appearance of the 130 farms and ranches in the watershed through the application and maintenance of land treatment on 200,000 acres of rangeland and cropland remaining to be treated.

   b. Improve and enhance the scenic quality of the watershed through restoration of vegetative cover on depleted areas of rangeland.

   c. Improve the visual quality of natural drainages or channels by the planting of tree vegetation.

   d. Provide enhanced beauty on 50 acres of landscaped park and green area adjacent to the multi-purpose reservoir.

   e. Construction of floodwater retarding structures and floodwater diversions will change the natural landscape.

   f. Planting of farm windbreaks will add variety to the natural landscape.

   g. Creation of a reservoir at the multi-purpose site will add variety to the natural landscape.

h. Increased traffic and number of people in the area will increase litter and detract from the rural setting.

2. Quality of Water, Land, and Air Resources

a. Reduce sediment deposition on about 6,500 acres of agricultural land and 630 acres of urban land. This will reduce the amount of wind-born dust in the air.

b. Reduce sediment yield to the Pecos River by about 10,000 tons annually. This will improve the water quality to a minor degree.

c. Reduce erosion and the deterioration of the land resource base to an acceptable level for continued sustained use as rangeland and irrigated cropland.

d. Construction of structural measures will denude areas of natural vegetation.

e. Air pollution from dust will be increased during construction.

f. The natural and developed environment will be protected from periodic flooding.

g. Wind erosion of cropland will be reduced by planting farm windbreaks.

3. Biological Resources and Ecosystems

a. Provide additional wildlife habitat areas on Cottonwood and Walnut Creeks by planting and maintaining tree and other suitable vegetation.

b. Provide and improve wildlife habitat at the 14 floodwater retarding structure sites by fencing the flood detention pool areas to exclude livestock.

c. Provide additional wildlife habitat by fencing the floodwater diversions to exclude livestock.

d. Provide a 120 surface-acre reservoir for fish and as a waterfowl resting area.

e. Provide winter cover crops on irrigated cropland for pheasant, quail, dove, other bird species, and for small mammals.

f. Change about 120 acres of land from a habitat for non-water-based wildlife to a water or aquatic habitat.

g. Wildlife habitat will be temporarily disturbed during construction of the structural measures and the application of some of the land treatment measures.

h. Planting farm windbreaks would provide cover and food for tree nesting birds.

4. Archeological and Historical Resources

a. The discovery, salvage, and preservation of important archeological artifacts will add to the knowledge of the presence and activities of pre-historic man in this area of the state.

b. Possible loss and disturbance of archeological material during construction.

Irreversible or Irretrievable Commitment of Resources

a. Grazing use on about 10,000 acres of rangeland would be lost with the construction and fencing of the 14 floodwater retarding structures and 7 floodwater diversions.

b. Commitment of about 532 acres of agricultural land to the multi-purpose structure and associated recreation and park development.

c. Commitment of labor, material, and energy for carrying out and maintaining the project measures of the environmental quality plan.

WORK PLAN

FOR

WATERSHED PROTECTION, FLOOD PREVENTION, AND RECREATION

COTTONWOOD-WALNUT CREEK WATERSHED

CHAVES AND EDDY COUNTIES, NEW MEXICO

Prepared Under the Authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress; 68 Stat. 666), as amended

Prepared by:

Cottonwood-Walnut Creek Watershed District
(Sponsor)

Central Valley Natural Resource Conservation District
(Sponsor)

Penasco Natural Resource Conservation District
(Sponsor)

Hagerman-Dexter Natural Resource Conservation District
(Sponsor)

New Mexico State Park and Recreation Commission
(Sponsor)

New Mexico Department of Game and Fish
(Sponsor)

With Assistance By:

U. S. Department of Agriculture
Soil Conservation Service

U. S. Department of the Interior
Bureau of Land Management
Fish and Wildlife Service

State of New Mexico

June 1975

WATERSHED WORK PLAN AGREEMENT

Between the

Cottonwood-Walnut Creek Watershed District
Central Valley Natural Resource Conservation District
Penasco Natural Resource Conservation District
Hagerman-Dexter Natural Resource Conservation District
New Mexico State Park and Recreation Commission
New Mexico Department of Game and Fish
(hereinafter referred to as the Sponsoring Local Organization)

State of New Mexico

and the

Soil Conservation Service

United States Department of Agriculture
(Hereinafter referred to as the Service)

Whereas, application has heretofore been made to the Secretary of Agriculture by the Sponsoring Local Organization for assistance in preparing a plan for works of improvement for the Cottonwood-Walnut Creek Watershed, State of New Mexico, under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress; 68 Stat. 66), as amended; and

Whereas, the responsibility for administration of the Watershed Protection and Flood Prevention Act, as amended, has been assigned by the Secretary of Agriculture to the Service; and

Whereas, there has been developed through the cooperative efforts of the Sponsoring Local Organization and the Service a mutually satisfactory plan for works of improvement for the Cottonwood-Walnut Creek Watershed, State of New Mexico, hereinafter referred to as the watershed work plan, which plan is annexed to and made a part of this agreement;

Now, therefore, in view of the foregoing considerations, the Sponsoring Local Organization and the Secretary of Agriculture, through the Service, hereby agree on the watershed work plan, and further agree that the works of improvement as set forth in said plan can be installed in about eight years.

It is mutually agreed that in installing and operating and maintaining the works of improvement substantially in accordance with the terms, conditions, and stipulation provided for in the watershed work plan:

1. Except as hereinafter provided, the Sponsoring Local Organization will acquire with other than Public Law 566 Funds such land rights as will be needed in connection with the works of improvement. (Estimated cost, $322,400). The percentages of this cost to be borne by the Sponsoring Local Organization and the Service are as follows:

Works of Improvement	Cottonwood-Walnut Creek Watershed District (percent)	New Mexico State Park & Recreation Commission (percent)	Service (percent)	Estimated Land Rights Cost (dollars)
Floodwater Retarding Structures 1, 3, 4, 5, 6, 7, 8, 13B, 14, 15, and 17A; Channels 300, 500, and Cottonwood; Floodwater Diversions 1, 2, 6, 7, 8 and Appurtenant Structures.	100	0	0	294,700
Multiple-purpose Structure Site 19 and Basic Recreation Facilities:				
Payment to landowner for about 533 acres.	0	50	50	26,600
Legal fees, survey costs, flowage easements, other.	100	0	0	1,100

The Sponsoring Local Organization agrees that all land acquired or improved with P.L. 566 financial or credit assistance will not be sold or otherwise disposed of for the evaluated life of the project except to a public agency which will continue to maintain and operate the development in accordance with the Operation and Maintenance Agreement.

2. The Sponsoring Local Organization assures that comparable replacement dwellings will be available for individuals and persons displaced

from dwellings, and will provide relocation assistance advisory services and relocation assistance, make the relocation payments to displaced persons, and otherwise comply with the real property acquisition policies contained in the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646, Stat. 1894) effective as of January 2, 1971, and the Regulations issued by the Secretary of Agriculture pursuant thereto. The costs of relocation payments will be shared by the Sponsoring Local Organization and the Service as follows:

	Cottonwood-Walnut Creek Watershed District (percent)	Service (percent)	Estimated Relocation Payment Costs (dollars)
Relocation Payments	27.1	72.9	0 1/

3. The Sponsoring Local Organization will acquire or provide assurance that landowners or water users have acquired such water rights pursuant to state law as may be needed in the installation and operation of the works of improvement. The estimated value or cost of water rights is $380,900 for recreational development.

4. The percentages of construction costs of structural measures to be paid by the Sponsoring Local Organization and by the Service are as follows:

Works of Improvement	New Mexico State Park & Recreation Commission 2/ (percent)	Service (percent)	Estimated Construction Cost (dollars)
Floodwater Retarding Structures 1, 3, 4, 5, 6, 7, 8, 13B, 14, 15, and 17A; Channels 300, 500, and Cottonwood; Floodwater Diversions 1, 2, 6, 7, 8, and Appurtenant Structures	0	100	5,925,000
Multiple-purpose Structure 19 (Joint costs)	13.8	86.2	1,311,700

1/ Investigation has disclosed that under present conditions the project measures will not result in the displacement of any persons, business, or farm operation. However, if relocations become necessary, relocation payments will be cost-shared in accordance with the percentages shown.

2/ The New Mexico State Park and Recreation Commission and the Cottonwood-Walnut Creek Watershed District will request construction funds from the New Mexico State Legislature for the Local Sponsors' share of the recreation development.

Works of Improvement	New Mexico State Park & Recreation Commission 1/ (percent)	Service (percent)	Estimated Construction Cost (dollars)
Specific Costs:			
Pool Blanketing	50	50	18,000
Shoreline Shaping	50	50	72,200
Basic Facilities	50	50	232,200
Streamflow Measuring Devices	100	0	8,000
Stocking Reservoir w/Fish	0	0	10,000 2/

5. The percentages of the engineering costs to be borne by the Sponsoring Local Organization and the Service are as follows:

Works of Improvement	New Mexico State Park & Recreation Commission (percent)	Service (percent)	Estimated Engineering Cost (dollars)
Floodwater Retarding Structures 1, 3, 4, 5, 6, 7, 8, 13B, 14, 15, and 17A; Channels 300, 500, Cottonwood; Floodwater Diversions 1, 2, 6, 7, 8, Multiple-purpose Structure 19, and Appurtenant Structures	0	100	481,000
Basic Recreation Facilities	50	50	21,000

6. The Cottonwood-Walnut Creek Watershed District and the Service will each bear the cost of Project Administration which it incurs, estimated to be $9,500 and $988,700, respectively.

7. The Natural Resource Conservation Districts will obtain agreements from owners of not less than 50 percent of the land above each reservoir and floodwater retarding structure that they will carry out conservation farm or ranch plans on their land.

8. The Natural Resource Conservation Districts will provide assistance to landowners and operators to assure the installation of the land treatment measures shown in the watershed work plan.

1/ The New Mexico State Park and Recreation Commission and the Cottonwood-Walnut Creek Watershed District will request construction funds from the New Mexico State Legislature for the Local Sponsors' share of the recreation development.

2/ This cost will be paid from funds of the New Mexico Department of Game and Fish.

9. The Natural Resource Conservation Districts will encourage landowners and operators to operate and maintain the land treatment measures for the protection and improvement of the watershed.

10. The Cottonwood-Walnut Watershed District will be responsible for the operation and maintenance of the structural works of improvement, except the recreation reservoir and basic facilities at Site 19, by actually performing the work or arranging for such work in accordance with agreements to be entered into prior to issuing invitations to bid for construction work.

    The New Mexico State Park and Recreation Commission will operate and maintain the basic facilities and operate the wells and pumps to supply water for the recreation reservoir and facilities. The New Mexico Department of Game and Fish will stock and maintain the fishery at Site 19.

11. The costs shown in this agreement represent preliminary estimates. In finally determining the costs to be borne by the parties hereto, the actual costs incurred in the installation of works of improvement will be used.

12. This agreement is not a fund obligating document. Financial and other assistance to be furnished by the Service in carrying out the watershed work plan is contingent on the appropriation of funds for this purpose.

    A separate agreement will be entered into between the Service and the Sponsoring Local Organization before either party initiates work involving funds of the other party. Such agreement will set forth in detail the financial and working arrangements and other conditions that are applicable to the specific works of improvement.

13. The watershed work plan may be amended or revised, and this agreement may be modified or terminated only by mutual agreement of the parties hereto except for cause. The Service may terminate financial and other assistance in whole, or in part, at any time whenever it is determined that the Sponsoring Local Organization has failed to comply with the conditions of this agreement. The Service shall promptly notify the Sponsoring Local Organization in writing of the determination and the reasons for the termination, together with the effective date. Payments made to the Sponsoring Local Organization or recoveries by the Service under projects terminated for cause shall be in accord with the legal rights and liabilities of the parties. An amendment to incorporate changes affecting one specific structural measure may be made by mutual agreement between the Service and the sponsor(s) having specific responsibilities for the particular structural measure involved.

14. No member of or delegate to Congress, or resident commissioner, shall be admitted to any share or part of this agreement, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.

15. The program conducted will be in compliance with all requirements respecting nondiscrimination as contained in the Civil Rights Act of 1964 and the regulations of the Secretary of Agriculture (7 C.F.R. 15.1-15.12), which provide that no person in the United States shall, on the grounds of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any activity receiving federal financial assistance.

16. This agreement will not become effective until the Service has issued a notification of approval and authorizes assistance.

Cottonwood-Walnut Creek Watershed District
Local Organization

By [signature]

Title Chairman

P.O. Box 235, ARTESIA, N.M. 88210
Address Zip Code

Date July 18 - 1975

The signing of this agreement was authorized by a resolution of the governing body of the Cottonwood-Walnut Creek Watershed District
Local Organization

adopted at a meeting held on 7-18-75

[signature]
Secretary, Local Organization

Rt. 1, Box 87, Lake Arthur, N.M. 88253
Address Zip Code

Date July 18, 1975

Central Valley Natural Resource Conservation District
Local Organization

By [signature]

Title Chairman

P.O. Box 235, Artesia, N.M. 88210
Address Zip Code

Date July 18 - 1975

The signing of this agreement was authorized by a resolution of the governing body of the Central Valley N.R.C.D.
Local Organization

adopted at a meeting held on 7-18-75

[signature]
Secretary, Local Organization

Rt. 1, Box 53, Lake Arthur N.M. 88253
Address Zip Code

Date July 18, 1975

Penasco Natural Resource Conservation District
Local Organization

By [signature]

Title Chairman

P.O. Box 235, Artesia, N.M. 88210
Address Zip Code

Date 7-18-75

The signing of this agreement was authorized by a resolution of the governing body of the Penasco N.R.C.D.
Local Organization

adopted at a meeting held on 7-18-75

[signature]
Secretary, Local Organization

Hope, N.M. 88250
Address Zip Code

Date 7-18-75

Hagerman-Dexter Natural Resource Conservation District
Local Organization

By Leroy Miles

Title Chairman

Hagerman N. Mex 88232
Address Zip Code

Date 7-18-75

The signing of this agreement was authorized by a resolution of the governing body of the Hagerman - Dexter N.R.C.D.
Local Organization

adopted at a meeting held on 7-18-75

Gilbert Gomez.
Secretary, Local Organization

Hagerman Nmex 88232
Address Zip Code

Date 7/18-75

New Mexico State Park and Recreation Commission
Local Organization

By Luis Sosa

Title Chairman

141 E. De Vargas
Santa Fe, New Mexico 87501
Address Zip Code

Date August 14, 1975

The signing of this agreement was authorized by a resolution of the governing body of the State Parks and Recreation Comission
Local Organization

adopted at a meeting held on August 14, 1975

Secretary, Local Organization

141 E. De Vargas
Santa Fe, New Mexico 87501
Address Zip Code

Date August 14, 1975

New Mexico Department of Game and Fish
Local Organization

By Robert H Forrest

Title Acting Chairman

Santa Fe, New Mexico 87503
Address Zip Code

Date August 29, 1975

The signing of this agreement was authorized by a resolution of the governing body of the New Mexico State Game Commission
Local Organization

adopted at a meeting held on August 29, 1975, at Portales, New Mexico

Secretary, Local Organization

Santa Fe, New Mexico 87503
Address Zip Code

Date August 29, 1975

Appropriate and careful consideration has been given to the environmental statement prepared for this project and to the environmental aspects thereof.

Soil Conservation Service
United States Department of Agriculture

Approved by:

Marion E. Strong
State Conservationist

June 18, 1975
Date

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WATERSHED WORK PLAN

COTTONWOOD-WALNUT CREEK WATERSHED
CHAVES AND EDDY COUNTIES, NEW MEXICO

JUNE 1975

SUMMARY OF PLAN

General Summary

The Cottonwood-Walnut Creek Watershed is located in the Pecos Valley in southeastern New Mexico. It is immediately north and northwest of Artesia and south and west of Lake Arthur, New Mexico. Part of the watershed is located in the Four Corners Economic Development Region. The remainder is located in an area designated as a chronic underemployment and unemployment area by the Public Works and Economic Development Act of 1965.

The watershed area includes 356.8 square miles (228,326 acres) of which 85.5 percent is rangeland; 10.6 percent is cropland; and 3.9 percent is urban, farmsteads, roads, and miscellaneous uses. Approximately 170 square miles of the watershed are in Chaves County, and 186.8 square miles are in Eddy County.

This plan is sponsored by: Cottonwood-Walnut Creek Watershed District; the Central Valley, Penasco, and Hagerman-Dexter Natural Resource Conservation Districts; New Mexico Department of Game and Fish; and New Mexico State Park and Recreation Commission. Technical assistance was provided by: Soil Conservation Service, United States Department of Agriculture; Bureau of Land Management, and Fish and Wildlife Service, United States Department of Interior; New Mexico State Engineer Office, New Mexico State Park and Recreation Commission, and New Mexico Department of Game and Fish.

Watershed Problems

Problems in the watershed include flooding of cropland along Cottonwood and Walnut Creeks and an increasing demand for recreation in an area deficient in recreational facilities. Additional water and related land resource problems within the project area are erosion, ineffecient on-farm irrigation water management, and poor wildlife habitat conditions caused by flooding and sedimentation. Damaging floods were reported in 1915, 1937, 1941, 1954, 1960, 1962, 1964, 1965, 1966, and 1967. Five or six damaging floods

were reported in 1941. Based on available records, it appears that the largest flood in 1941, and the 1954, 1964, and 1965 floods would have a frequency of a storm to be expected once in 50 to 100 years (2 to 1 percent chance of occurrence). Damages from floods begin in the Cottonwood Creek drainage at the 70 percent chance of occurrence and in the Walnut Creek drainage at the 50 percent chance of occurrence.

Project Objectives and Installation

The objectives of the project are to provide effective land treatment on watershed lands, provide protection from floods for agricultural and urban lands, improve the utilization of existing water supplies, and provide a recreational project development on Cottonwood Creek with public access.

With completion of the proposed structures, flood damages in the watershed will be reduced by approximately 91 percent. Sediment delivered from the watershed to the Pecos River will be reduced by 45 percent with the installation of project measures.

Land Treatment

Land treatment measures will include practices for watershed protection, land improvement, irrigation water management, and sediment reduction. Land treatment measures will be established by the landowners and operators of watershed lands and the Bureau of Land Management during the eight-year installation period. Emphasis will be placed on proper grazing use of private, state, and federal rangelands and improved water and soil management practices on the irrigated cropland.

The estimated cost of land treatment measures is $2,254,500. The Public Law 566 portion is $82,300 and will consist entirely of accelerated technical assistance. The share of other funds is $2,172,200. Of this, $52,700 is from the Soil Conservation Service's going program of technical assistance; $8,100 is from the regular funds of the Bureau of Land Management; and $2,111,400 is from other sources with assistance, as available, from the Great Plains Conservation Program of the Soil Conservation Service and the Rural Environmental Conservation Program.

Structural Measures

The structural measures included in this plan consist of 11 floodwater retarding structures, 1 multiple-purpose structure for flood prevention and recreation with associated basic recreation facilities, 5 floodwater diversions, and 3 channels. The total installation cost of the structural measures is estimated to be $9,800,600, of which $8,711,000 are Public Law 566 funds, and $1,089,600 are costs to other funds. An eight-year installation period is planned.

The multi-purpose structure, Site 19, has 3,007 acre-feet capacity for floodwater detention and sediment storage and provides for 1,143 acre-feet of storage in the recreation pool. The estimated installation

cost of Site 19 with the basic recreational facilities is $2,169,400, of which $1,400,400 are PL-566 funds, and $769,000 are from other funds. Public access to Site 19 and basic facilities will be provided, and these facilities will become a state park. The floodwater retarding structures will have an aggregate capacity of 33,228 acre-feet of floodwater detention and sediment storage. The five floodwater diversions consist of about 13.9 miles of construction. The three channels include approximately 9.7 miles of channel work of which about 4.8 miles is new channel construction, and about 4.9 miles is channel enlargement. The channel enlargement is on Cottonwood Creek, an existing stream with limited intermittent flow, and the upper 1500 feet of Channel 500, an undefined natural channel with ephemeral flow.

Annual operation and maintenance cost of the structural measures is estimated to be $80,400, of which $19,700 are for operation, maintenance, and replacement of basic recreation facilities; $14,500 are for operation and maintenance of the recreation pool and fishery; and $46,200 are for the dams, diversions, and channels.

Annual Benefits

The estimated benefits accruing to the structural measures average $767,900 annually and are distributed as follows:

Floodwater Damage Reduction	$463,400
Recreation	98,100
Redevelopment	148,700
Secondary	57,700
TOTAL	$767,900

The above benefits include $187,300 flood damage reduction benefits that are realized outside the project area in Damage Areas 1 and 4 on the north side of Artesia (Figure 7).

The ratio of average annual project benefits from structural measures, $767,900, to the average annual cost of structures, $658,100, is 1.2:1.

Environmental Impacts

The installation of the project will result in more efficient use of land and water resources; reduce average annual flood damage by 91 percent in the watershed; reduce sediment yield from the watershed to the Pecos River by 45 percent; provide flood protection to 100 homes and 10 business firms now in existence in Artesia from floods up to and including the 1 percent chance of occurrence flood; protect 6,396 acres of irrigated cropland from flood damage; and provide a recreation development and state park for the community and the area.

Adverse effects from the project include commitement of about 7,645 acres of land for installation of structural measures; use of 2,400 acres of rangeland will be temporarily interrupted by floodwater in detention pools and along floodwater diversions; and some unavoidable air and noise pollution during construction of the project. Identified cultural sites will be disturbed when they are excavated to salvage archeological material prior to project construction. About 750 acre-feet of water will be lost annually by evaporation from the recreation pool at Site 19.

WATERSHED RESOURCES - ENVIRONMENTAL SETTING

Physical Data

The Cottonwood-Walnut Creek Watershed is located in southeastern New Mexico in parts of Chaves and Eddy Counties. Approximately 170 square miles of the watershed are in Chaves County, and 186.8 square miles are in Eddy County. The watershed has a total area of 356.8 square miles (228,326 acres).

The estimated population of the watershed is 650, which is essentially rural. Artesia, which adjoins the lower south side of the watershed, is the primary trade center, with a population of 10,300. Thirty miles to the north is Roswell with a population of 34,000, and 36 miles to the south is Carlsbad, with a population of 21,300.

The watershed is located in the Rio Grande Water Resource Region. 1/ The Rio Grande rises in the mountains of southern Colorado and flows south, across New Mexico, into Texas at El Paso. From El Paso to the Gulf of Mexico--700 airline miles and 1,244 river miles--it forms the boundary between the United States and Mexico.

The principal tributaries of the Rio Grande are the Conejos River and Alamosa Creek in Colorado; the Rio Chama, Jemez River, and Rio Puerco in New Mexico; the Pecos River in New Mexico and Texas; the Devils River in Texas; and the Rio Conchas, Rio Salado, Rio Alamo, and Rio San Juan in Mexico. The Pecos, the longest tributary, is separated from the Rio Grande in the upper basin in New Mexico by the Sangre de Cristo Mountain Range, an extension of the southern Rockies.

A semiarid to arid climate and low and/or erratic rainfall are characteristic of the Region. Average annual precipitation ranges from 30 inches in the high mountains and lower coastal plains to only 8 inches in the middle valley areas.

The regional economy is based primarily on agriculture, with livestock production predominating. Manufacturing is of relatively minor importance. In parts of the basin mineral extraction is significant. Recreation, tourism, and resort trade are increasing as sources of revenue.

1/ The Nation's Water Resources - 1970, U.S. Water Resources Council.

The watershed is in the Upper Pecos Water Resource Subarea. This area extends from the river's headwaters in the Sangre de Cristo Mountains in San Miguel County, New Mexico, to Red Bluff Reservoir at the New Mexico-Texas state line. It includes San Miguel, Guadalupe, De Baca, Chaves, and Eddy Counties, New Mexico (Water Resource Subarea 1306 1/).

The average annual runoff within this Subarea is fairly well distributed; 57 percent occurs between May and September. Torrential rains which move in from the Gulf of Mexico during this period produce the major floods. Runoff from snow melt is negligible.

The Pecos River is highly mineralized because great quantities of evaporites and limestone are within reach of circulating groundwaters. Sediment production within this Subarea, however, is considerably less than that of the Rio Grande drainage area.

The terrain of this Subarea is rugged and mountainous in the northern sector where the headwaters of the river are located and also in the southwestern sector. The remainder of the Subarea is undulated to flat, and consists primarily of rangeland. The southern sector also includes a substantial amount of fairly level cropland.

Population in the Subarea is widely scattered. The 1970 population was 113,900. 2/ The six main population centers are Las Vegas, Santa Rosa, Fort Sumner, Roswell, Artesia, and Carlsbad. Small unincorporated towns constitute the other population centers. The 1970 urban population was 83,650, or 74 percent of the Subarea total. The remaining 26 percent of the population (30,250 inhabitants) is rural, with a density of about 3 people for each 2 square miles.

The predominant water use in the Subarea is for irrigation. It is estimated this comprises 90 percent or more of the total use. In many areas withdrawals exceed recharge rates.

The watershed includes Walnut Creek, Cottonwood Creek with its north and south branches, and several smaller drainages between Artesia and Cottonwood Creek that are tributaries to Cottonwood Creek. The stream characteristics for Walnut Creek Channel and Cottonwood Creek Channel are similar. There is some variation in alignment, shape, and size. The side slopes and bottom are irregular. The gradients of the streams are approximately 65 feet in a mile for the eastern portion of the watershed. Gradients are steeper in the western or upper end of the watershed.

The course of Walnut Creek, an ephemeral stream, is entirely within Township 15 South in Chaves County. The northern boundary is approximately seven miles north of the south Chaves County line. It heads in the foothills of the sacramento Mountains at an elevation of 4,200 feet above mean sea level and flows eastward into the Pecos River at a point approximately 8.5 miles north of the City of Artesia. The southern

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1/ Water Resource Subareas - 1970, U.S. Water Resources Council.
2/ 1970 census data.

boundary of Walnut Creek is the northern boundary of the Cottonwood Creek drainage. The drainage basin of Walnut Creek is approximately 26 miles long and 4.5 miles wide and encompasses 111.5 square miles. The channel, which is unmodified and well-defined, flows through irrigated cropland for a distance of about five miles. The gradient through the cropland is approximately one percent.

Cottonwood Creek, with its north and south branches and other tributaries, has a drainage basin about 30 miles long and eight miles wide and encompasses about 245.3 square miles. Springs are a water supply source for a portion of Cottonwood Creek. These springs now have an average annual flow of less than one cubic foot per second. Cottonwood Creek heads in the foothills of the Sacramento Mountains at 4,500 feet above mean sea level. North Cottonwood Creek rises in Chaves County and flows eastward through western Eddy County. South Cottonwood Creek and North Cottonwood Creek join together approximately 10 miles west of the Pecos River and flow through irrigated cropland between this point and Alternate Highway U.S. 285. The gradient of the channel through the irrigated cropland is approximately one percent. Both South Cottonwood Creek and North Cottonwood Creek are unmodified, well-defined, ephemeral streams. For a short distance below the junction of the north and south branches, Cottonwood Creek is a perennial stream with a low base flow. The lower end of Cottonwood Creek has intermittent flow into the Pecos River.

The quality of groundwater and the low base flow in the area of proposed Site 19 is quite variable. Tables in the appendix indicate chemical analysis data from published sources and recent field tests by the Soil Conservation Service.

It is noted from these data that hydrogen sulphide was analyzed from one well producing water from the San Andres Limestone. Chloride (Cl) measurements ranged from 16 to 139 parts per million (ppm) in the water produced from the Quaternary alluvium and from 15 to 20 ppm in the underlying San Andres Limestone. Groundwater temperatures from selected wells ranged from 63 degrees to 72 degrees F. at times of measurement. Total dissolved solids range from 1,026 to 1,224 parts per million in the San Andres Limestone and from 587 to 1,998 parts per million in the Quaternary age alluvium. The pH of water in the San Andres Limestone range from 6.9 to 8.0 in the samples tested. Total hardness, as calcium carbonate, was 1,179 parts per million in the San Andres Limestone water, and 2,070 parts per million in the Quaternary age alluvium.

Chemical analysis of surface water by Soil Conservation Service personnel at the small dam upstream of proposed Site No. 19 indicated that on June 22, 1966 the water temperature was 82 degrees F., and total dissolved solids were 4,200 ppm. In 1965 a bass, bluegill, and catfish population existed in the waters impounded by the small dam on Cottonwood Creek. Additional information on the surface water obtained in May 1975 show the pH was 8.5 and total hardness 1,060 parts per million.

Tributary drainages in the southeast corner of the watershed head approximately 7 miles west of Artesia, New Mexico and flow eastward to the lower end of Cottonwood Creek. This portion of the watershed has four main ephemeral drainage systems which lie between Artesia, New Mexico and the main channel of Cottonwood Creek. Each drainage system flows eastward through irrigated cropland. Approximately 2.26 square miles of the watershed west of Artesia drain from the Artesia, New Mexico municipal airport and flow through the north portion of the city.

The topography is mostly rolling. The upper portion is rangeland, devoted to the production of livestock. Tracts along the valleys and the lower end of the watershed are irrigated cropland. Within the project area there is a fringe of wetlands along the Pecos River. This wetland type is dominated by saltcedar, and is classified as Type 1--seasonally flooded basins and flats. There are no other wetlands within the project area.

The watershed area includes 228,326 acres of which 24,238 acres are irrigated cropland; 195,267 acres are rangeland; and 8,821 acres are in miscellaneous use, such as farmsteads, roads, highways, railroad, and built-up areas. Approximately 68,130 acres of the watershed are federal land (public domain); 37,460 acres are New Mexico State land; and 122,736 acres are privately-owned land.

There are two soil and water resource problem areas in the watershed. The rangeland is a grassland community consisting of burrograss, tobosa, creosotebush, and some blue grama on the uplands; and alkali sacaton, mesquite, and saltcedar on the bottomlands. The present in-range conditions appear to be static. The primary conservation treatment needed involves proper utilization of the desirable grasses to increase production and improve range conditions. All of the cropland is irrigated. Irrigation water management is the principal conservation treatment needed, along with lining irrigation ditches and installation of irrigation pipeline.

The watershed is located in the Pecos Valley section of the Great Plains Physiographic Province. 1/ The area of the upper 14 miles of Cottonwood Creek and the upper 3 miles of Walnut Creek is underlain by San Andres Limestone of Permian age. Both streams, for the next eight miles, are in the outcrop of the Artesia Group of Permian age. The Artesia Group which overlies the San Andres Limestone consists of hard limestone and dolomite, red sandstone, shales, siltstones, and gypsum.

The lower reaches of the watershed are underlain by recent valley fill and older alluvium. The older alluvium consists of indurated red sandstone, siltsone, shale, and pebble conglomerate. This material that overlies the Artesia Group is as much as 300 feet thick. 2/ The horizontal and vertical bedding planes of these units are irregularly distributed. The attitude varies from steeply dipping to flat.

1/ Physiography of Western United States, Fenneman, (NM) 1931.
2/ Geology and Ground Water Resources of Eddy County, New Mexico, State Bureau of Mines and Mineral Resources, Ground Water Paper No. 3, 1962.

The primary source of water for domestic livestock and irrigation use is Artesian and shallow wells. The principal aquifers are the San Andres Limestone, the Artesia Group, and the overlying Quaternary age alluvium. Minor quantities of irrigation water are obtained by diversions of seasonal streamflow. Water from both underground and surface sources is fully appropriated and adjudicated by the courts.

Thickness and type of flow of the principal aquifers are: San Andres Formation, 1,000 feet--the source of artesian supply; Artesia Formation, 600-900 feet--the source of some artesian supply; and Quaternary alluvium, up to 300 feet--the source of shallow water supply. 1/ The shallow wells are locally limited in supply due to the lenticular nature of the water-bearing formations.

Recharge of these aquifers occurs for the most part in the San Andres outcrop area. This area extends from the uppermost portions of the watershed westward to the crest of the Sacramento Mountains. The overlying Artesia Formation and Quaternary alluvium are primarily recharged by the upward percolation of the artesian waters of the San Andres Formation. Some recharge occurs in the limited outcrop area of the Artesia Formation, principally along the stream channels.

Soils in the watershed are generally shallow and rocky in the west or upper end of the watershed and deep and loamy in the east or lower end.

There are five major range sites in the watershed. These are: Salty Bottom Lands in a band one to four miles wide along the Pecos River; Bottom Lands scattered throughout the watershed on Pima soils along the drainage ways; Loamy on the dominant range site in complex with the Shallow sites in a large area of Reagan-Upton soils in the middle part of the watershed; Shallow occurring in a large area in the upper part of the watershed and as the dominant range site in complex with Loamy sites in the Upton-Reagan soil association of the north middle part of the watershed; and Limestone Hills in the western part of the watershed.

Climax vegetation on these sites is principally black grama, blue grama, and sideoats grama grasses; winterfat with four-winged saltbush on the loamy and bottomland sites; and alkali and giant sacaton and vine mesquite grasses on the bottomland sites. When deterioration of the sites occurs, the predominant invading species are burrograss and creosotebush on the upland and loamy sites; and tobosa grass, catclaw, Apache plume, salt-cedar, and mesquite on the bottomland.

Known mineral resources within the watershed at the present time are two producing gas and oil wells. There are no known metallic minerals in the area. Caliche pits are opened as needed for road construction, but are not permanent installations.

1/ Geology and Ground Water Resources of Eddy County, New Mexico, State Bureau of Mines and Mineral Resources, Ground Water Paper No. 3, 1962.

Average annual precipitation is 11.75 inches as derived from precipitation records at Artesia. Most of the precipitation falls as high-intensity rain during thunderstorms of comparatively short duration. Extremes in precipitation range from a low of 3.97 inches in 1917 to a high of 36.31 inches in 1941. 1/

The climate is dry and moderately hot, with a mean average annual temperature of 60.8 degrees F. The extreme temperatures range from a low of minus 35 degrees F. to a high of 111 degrees F. The average frost-free period is 196 days, generally extending from April 14 to October 17. 1/

Economic Data

Present land use is as follows:

Land Use	Private	State	Bureau of Land Management	Total	Percent
Irrigated Cropland	24,238	--	--	24,238	10.6
Rangeland	91,916	36,701	66,650	195,267	85.5
Miscellaneous 2/	6,582	759	1,480	8,821	3.9
TOTAL	122,736	37,460	68,130	228,326	100.0
Percent	53.8	16.4	29.8	100	

The irrigated cropland is divided into 112 operating units that range in size from 80 acres to 1,000 acres. The typical size of farm units in the irrigated portion of the watershed is 320 acres. The principal crops grown on irrigated land are cotton and alfalfa, 35 and 52 percent respectively. Annual crop production averages about two bales per acre for cotton and six tons of hay per acre for alfalfa. Other crops grown are corn, grain, sorghums, small grains, and miscellaneous vegetables. Most of the farm owners also raise livestock.

There are 18 ranches in the area, with an average size of 11,000 acres. The rangeland is used for both cattle and sheep production. Some cattle-feeding operations now in existance show promise for considerable development in the future. That would increase the demand for growing more feed grains and ensilage crops. An increase in acreage devoted to vegetable production is probable in the near future.

1/ U.S. Weather Bureau.
2/ Includes lands for residential areas, roads, highways, irrigation facilities, and idle land.

The value of agricultural land ranges from $35 to $1,000 per acre. Rangeland in the upland areas is considered to be worth $35 to $200 per acre, while irrigated cropland in the lower end of the watershed is worth $800 to $1,000 per acre. Approximately 64 percent of the farms and ranches in the watershed contain land that is located on the floodplain.

Cottonwood Creek surface water rights were adjudicated in 1934. Ground water rights in the Roswell-Artesian Basin were adjudicated in 1966.

The lower reaches of the watershed are crossed from north to south by U.S. Highway 285 and Alternate U.S. Highway 285. The Atchison, Topeka, and Santa Fe Railroad also traverses the lower reach of the watershed. State Road 13, better known as the "Y.O. Crossing Road", crosses the upper limits of the watershed and coincides with the upper watershed boundary. The lower half of the watershed, which includes the irrigated cropland, is well served by state and county roads.

The median family income presently averages $7,541 for the two county area in which the watershed is located. This compares to the state average of $7,849. 1/

The major sources of income in the two counties in which the watershed is located are distributed approximately as follows: 2/

Sources of Income	Percent
Wages and Salaries	58
Business and Professional	7
Agriculture	10
Property	15
Other Miscellaneous Income	10

The average percent of unemployed workers in Chaves and Eddy Counties increased from 4.1 to 6.4 percent in the period from 1961 to 1971. During this same period, the unemployment rate for New Mexico declined from 6.4 to 4.8 in 1969 and then increased to 6.4 percent by 1971. 3/ At the same time, the number of workers declined in six of the ten sectors of the economy. These six sectors were agriculture; construction; wholesale and retail trades; mining, transportation, utilities, and communications; and finance, insurance, and real estate. 3/

1/ 1970 Bureau of the Census Data, "General Social and Economic Characteristics".

2/ New Mexico Statistical Abstract, 1970, Bureau of Business Research, University of New Mexico.

3/ Employment Security Commission of New Mexico.

Fish and Wildlife Resources

Fishery resources are extremely limited within the project area. The middle reach of Cottonwood Creek is a perennial stream with low sustaining flows. A single farm pond impoundment on the creek supports a fishery of warm water species. In addition, the Pecos River, bordering the project area, supports a warm water fishery.

Wildlife resources include four distinct habitat types which are associated with land uses and riparian influences. These are:

1. The rangeland habitats of the Southern Desert resource area that support low density populations of mule deer, antelope, jack rabbit, coyote, scaled quail, small mammals, reptiles, and associated songbirds.

2. The habitats associated with perennial and ephemeral watercourses which traverse the rangelands. These habitats also support the wildlife species of the rangeland types, and in addition, support ringneck and whitewing pheasant, cottontail rabbit, mink, skunk, raccoon, several amphibians, shorebirds, mourning doves, and tree nesting songbirds. Field investigations indicate that on the 9.7 miles of natural and new drainageways where construction is planned, there is no high quality wildlife habitat in Channel 500; 200 feet of high quality wildlife habitat in Channel 300; and 5,800 feet of high quality wildlife habitat in the Cottonwood Creek Channel. On Walnut Creek there is 4,550 feet of high quality wildlife habitat that will not be affected by project installation.

   Eleven floodwater retarding structure sites and one multi-purpose structure site (Site 19) occur within this habitat type. Examination of the sites indicates that four of the floodwater retarding structure sites (Sites 4, 6, 7, and 8) and Site 19 contain existing habitats of high quality.

3. The cropland habitats are located on areas of relatively flat soils and are crossed by the natural drainageways. Depending upon the crop being grown, these habitats may be important winter feeding areas for large numbers of migratory sandhill cranes, ducks, and geese. Other wildlife species which utilize the cropland habitats include the ringneck and whitewing pheasant; mourning doves; blackbirds and other flocking, ground feeding birds; cottontail rabbits, small mammals; and ground nesting songbirds. The woody vegetation growing along the natural drainageways provides important roosting, nesting, and escape cover within this cropland habitat.

4. The salty bottom land range site that occurs along the Pecos River provides another distinct habitat type which supports

most of the species found in the other habitats. This bottom land habitat type contains remnant stands of saltcedar that once vegetated a much larger area. The saltcedar vegetation provides a heavily used nesting area, with production of up to 22 mourning dove per acre reported for the project area. This habitat provides open water during the winter months which is heavily utilized as resting areas by migratory waterfowl.

There are no known sources of pollution that affect fish and wildlife resources.

Public access is largely available over most of the rangeland habitat, the upper portions of the natural drainageway habitats, and the bottom land habitats. A private hunting association controls access to the cropland habitats and the portions of the lower drainageway habitats which cross the croplands.

Populations of ringneck and whitewing pheasants are the result of releases of pen-reared birds. Maintenance releases are required to support a significant huntable population.

Wintering populations of cranes and waterfowl represent an important wildlife resource. The role of private lands, such as the bottom land and cropland habitats, is to provide important feeding areas which complement those provided by managed waterfowl refuges on the Pecos River.

The tree vegetation of the drainageways and bottom land habitats provides important nesting sites for mourning doves. As other areas of suitable nesting sites up and down the river are reduced or eliminated by planned water salvage projects and new impoundment construction, the importance of the remaining tree vegetation will increase.

The rangeland habitat type found within the project area does not represent any qualities of particular significance. Wildlife populations are not large, and are similar to populations occurring over a very large land area in this part of the state.

Recreational Resources

Within or nearby the city of Artesia there are two city parks, three golf courses, two hunting preserves, one water sports area, and numerous horse riding facilities. The 1971 Outdoor Recreation Comprehensive Plan for New Mexico indicates that there are 188,273 acres of public recreation lands in Eddy County. In Planning and Development District No. 6, where Artesia is centrally located, the major recreation needs were delineated as: tennis courts, developed parks, picnic areas, and boating areas. The report indicates that a five-year acquisition and development schedule will provide: an 18-hole golf course at Carlsbad, a regional park and lake at Hobbs, a state park and lake at Artesia, a wilderness area

at Carlsbad, expansion of a city park at Carlsbad, picnic and campground facilities in Lincoln National Forest, picnic facilities and scenic drive expansion at White Sands National Monument, and a proposed Pecos River Trail system.

Existing public and private recreation facilities in Planning and Development District No. 6 have been identified and are as follows:

1.	Picnic units	1,017
2.	Swimming pools and beaches	67
3.	Acres of land intended for hunting	6,320
4.	Acres of water surface of lakes for fishing and recreation	6,733
5.	Miles of fishing streams	54
6.	Number of boat accesses to lakes	4
7.	Available boat moorings	40
8.	Miles of trails	27

None of these facilities are in the watershed. A few of the picnic units are located nearby in Artesia's community park. There is a current shortage of facilities for most types of recreational activities within Planning District No. 6.

The future potential of recreation by 1990 in the area of the watershed is indicated by the change in demand for the 10 most popular current activities.1/ These changes are shown in the following table according to the popularity of the activity:

Activity	Percent Currently Engaging in This Activity	Percent Change In Demand 1970-1990
1. Pleasure driving	63	+ 72
2. Picnicking	62	+ 74
3. Walking for pleasure	58	+ 84
4. Attending outdoor sporting events	54	+ 66
5. Fishing	53	+ 45

1/ Outdoor Recreation - A Comprehensive Plan for New Mexico - 1971.

Activity	Percent Currently Engaging in This Activity	Percent Change In Demand 1970-1990
6. Car Sightseeing	52	+ 75
7. Pool Swimming	45	+ 84
8. Hunting	40	- 1
9. Bicycling	37	+ 44
10. Horseback riding	27	+ 74

The limited recreational resources in the area are fully utilized and oftentimes crowded since they are confined to the facilities existing in the community park at Artesia. These facilities consist primarily of golfing and picnicking.

There are no known sources of pollution that affect recreational resources.

Archeological and Historical Values and Unique Scenic Areas[1/]

"The Museum of New Mexico had no record in its archeological survey catalog of earlier surveys in the Cottonwood-Walnut Drainage. This fact, plus the relatively small area covered by the survey, made it impossible to predict the frequency and variability of cultural remains in the area. This problem was further compounded by the proximity of the survey localities to areas of intensive agriculture and settlement. A significant percentage of the survey area was either currently under cultivation, or had been in the past, thereby rendering the archeological inventory incomplete.

"Approximately seven square miles were covered by the survey. All areas were repeatedly traversed on foot to locate any cultural remains, i.e., pottery fragments (sherds) and chipped or ground stone tool debris (debitage) are indicators of archeological sites; broken glass, crockery, metal, and factory-made items for sites of the historic period. Concentrations of sherds or debitage (or lithic scatter) were considered as archeological sites. . . . , it was decided to disregard most historic refuse areas if they were not associated with the remains of some sort of a structure or dwelling. This procedure excluded from consideration most historic materials dating more recently than the mid-1930's, but included sites dating from the late nineteenth century onward to the third decade of the twentieth century.

1/ An Inventory of Archaeological and Historical Remains in the Cottonwood-Walnut Drainage, Chaves and Eddy Counties, New Mexico - August 1974. (Museum of New Mexico.)

"A total of 14 archeological/historical sites were located and recorded. Of these four were manifestations of the Jornada Branch of the Mogollon Culture. The remaining 10 sites were homesteads of the historic Anglo period, probably constructed after the arrival of the railroads in the late 1800's.

"The major population centers of the Jornada Branch of the Mogollon Culture are located in the Sacramento Mountains, the Tularosa Basin, the Jornada del Muerto, and lower Rio Grande Valley. The sites encountered on the Cottonwood-Walnut survey constitute extensions of the Jornada Branch into the extreme eastern periphery of the sedentary, agricultural Mogollon Culture, except for some local manifestations in the southeastern corner of New Mexico. Judging from the types of sites encountered on the survey, the Jornada sites were relatively impermanent, probably seasonal, occupations. Conceivably, they may not be sites of Jornada people at all, and may have been entirely different people who merely obtained Jornada pottery by trade with settlements to the north or west. Of all the sites encountered on the survey, the Jornada sites--if that is what they are, offer the greatest potential for obtaining valuable information concerning the prehistoric occupants of the southern Pecos Valley.

"Although they were certainly in the general area during the late prehistoric and much of the historic period, the various Apache and other Plains Indian groups apparently did not use the survey localities for anything but passing through.

"None of the sites recorded warrant being listed on either National or State Registers of significant sites, at least not in terms of their being exceptional examples of architecture, homes of important persons, locations of important events in the history of the State or Nation, or major settlements of prehistoric Indians. However, further investigation of at least some of the sites is warranted so that when construction of the needed flood control structures begins, some record of the contents of the earliest prehistoric and the earliest historic settlements in the area will have been made.

"In terms of mitigating what might be considered an adverse impact on the historic period sites, little can be recommended other than conducting excavations of several of the dugouts and associated structures and refuse. Relocation of the flood control structures is not warranted. The same can be said for the prehistoric sites. The prehistoric sites do not compare with the large pueblos of western New Mexico, but they are important in terms of their being among the easternmost of the settlements of the sedentary Jornada Branch of the Mogollon Culture, and their contents should be investigated. By 'investigated' it must be understood that this means careful excavation and recording by qualified professional archeologists assisted by amateur archeologists or unskilled labor under direct supervision by the professional archeologist. Materials and data from such

excavations should be deposited in an educational institution or museum where they may be properly stored and cared for, and be available for examination by the archeologists and the general public.

"Although many of the historic sites listed in the inventory are recommended for excavation, test excavations may indicate that further digging is unnecessary. Some sites may need only a few trenches to collect a sample of associated artifacts and data; others may be found to warrant more complete excavation."

The National Register of Historic Places was consulted. No archeological or historic sites in the watershed are listed in the National Register.

Soil, Water, and Plant Management Status

There has been little change in land use, and this trend or lack of change will probably continue for the following reasons: (1) All irrigation water is appropriated so no more land will go into cultivation; and (2) there are little or no factors of production committed to marginal or sub-marginal areas.

Activities of the Central Valley, Hagerman-Dexter, and Penasco Natural Resource Conservation Districts include working with individual farmers and ranchers to develop basic conservation plans with emphasis on proper range use and irrigation water management. The districts also assist local units of government to promote proper land use, provide conservation education, sponsor Public Law 566 watershed projects, and support the Sureste RC&D Area for resource conservation and development. Within the three natural resource conservation districts there are 130 operating farm and ranch units, of which 101 are cooperators and 80 have basic conservation plans. Approximately 89 percent of the watershed area is covered by District Cooperative Agreements and 65 percent of the planned practices are presently applied.

Other programs and agencies in the area are assisting in the improvement of resource management. The assistance from the Great Plains Conservation Program, New Mexico Extension Service, Bureau of Land Management, Agricultural Stabilization and Conservation Service, New Mexico State Land Office, and others has been excellent.

WATER AND RELATED LAND RESOURCES PROBLEMS

LAND TREATMENT

A declining water table during the last decade and the resulting limitations on irrigation water are the most serious problems facing irrigation farmers. Coping with these problems requires efficient use of irrigation water and the possibility of growing crops that use less water.

Leveling land, lining ditches, and installing irrigation pipelines will provide facilities for more efficient irrigation.

Rangeland that has been depleted of desirable forage species is a problem on some ranches near the Pecos River. Economic returns for range improvement are small and prolonged because of the slow rate at which range conditions improve in this climatic zone.

Ranchers have been reluctant to invest the time and sacrifice the current income necessary to achieve improved range conditions through deferred grazing. Range seeding trials in this location generally have been unsuccessful in re-establishing stands of climax type vegetation. Additional fences and water developments are needed to obtain better livestock distribution and to initiate improved grazing systems.

FLOODWATER DAMAGE

The watershed area consists of two main areas with a history of flooding. These areas include the Walnut Creek drainage and Cottonwood Creek drainage.

Floods are principally caused by local short-duration, high-intensity thunderstorms covering a few square miles. These floods characteristically have high peak flows, small volumes, and occur during the summer and early fall months. General storms over all or most of the watershed with comparatively long durations do occur. Floods from this source have large volumes and may have peaks exceeding those from local thunderstorms. Damaging floods occurred in 1915, 1937, 1941, 1954, 1960, 1962, 1964, 1965, 1966, and 1967. Five or six damaging floods were reported in 1941. Based on available records, it appears that the largest flood in 1941, and the 1954, 1964, and 1965 floods would have an expected chance of occurrence of once in every 50 to 100 years.

Floods damage crops, irrigated land, irrigation facilities, roads, highways, farm buildings, farm improvements and equipment, and the railroad. An additional damage mentioned by several landowners was the spreading of weed seeds by the floodwater. The succeeding weed crops have caused considerable additional expense in cultivation and eradication.

Floodwater and sediment damage from the Walnut Creek drainage occurs adjacent to, and in a band along the main channel and tributaries north of the main channel through the irrigated cropland. This area of damage begins about four miles west of Alternate U.S. Highway 285 and extends to the Pecos River. Damages begin from a storm having a 50 percent chance of occurrence.

Floodwater and sediment damage from the Cottonwood Creek drainage occurs adjacent to and in a band along the main channel through the irrigated cropland. This area of damage begins approximately three miles above the point where South Cottonwood Creek and North Cottonwood Creek come together and extends to the Pecos River. The runoff from drainages west and north

of Artesia cause local floodwater and sediment damage to irrigated cropland along the main channels of each drainage before entering the floodplain of Cottonwood Creek. Flood flows from the tributary drainage west of Artesia enter the north end of the city causing floodwater and sediment damage to urban property. Damage begins from a storm having a 70 percent chance of occurrence.

The most damaging flood on record was in October 1954. This flood caused an estimated damage of $275,000 (1954 prices). This flood inundated about 3,600 acres of cropland. Crop damage was estimated at $185,000. This crop damage included the loss of 1,000 bales of cotton, 250 tons of alfalfa, and the lowering of the grades and quality of cotton and alfalfa that was not actually destroyed. Aproximately 550 head of sheep, several hogs, and some poultry were drowned. Estimated loss of livestock and poultry was $9,500. About 400 acres of irrigated land damaged from the 1954 storm had to be releveled. Cost of releveling and smoothing this land was about $12,000.

Traffic was delayed on Alternate U.S. Highway 285, on State Roads 350 and 351, and on county roads. Some damage occurred to paved and gravel-surfaced roads. The Atchison, Topeka, and Santa Fe Railroad was damaged and some delay in traffic occurred.

In 1964, a storm west and north of Artesia on Cottonwood Creek tributaries caused flood damages of $184,000 and inundated about 1,900 acres. The 1965 flood on Walnut Creek caused an estimated $163,000 in damages and inundated 1,400 acres (1964 and 1965 prices).

Average annual direct damage from floodwater and sediment in the watershed is estimated to be $278,400 under future conditions without the project. This estimate is based on more intensive use of irrigated land and higher value crops. Other flood damage, which occurs outside the watershed, from flood run-off in the watershed, amounts to an estimated $187,300 average annual damage to urban property in the north end of Artesia.

Indirect damage from flooding in the watershed results from interrupted use of farm labor, delays and detours on roads made impassible, and loss of income from regular employment for the time required to repair flood damage. Indirect damage averages $28,000 per year in the watershed.

EROSION DAMAGE

Soil erosion is relatively low. The average annual gross erosion rate is estimated at 1.25 tons per acre. Of this amount it is estimated that sheet erosion accounts for 85 percent of the damaging sediment, and gullying and streambank erosion accounts for the remaining 15 percent.

SEDIMENT DAMAGE

The damage to crops and pasture from sediment deposition is relatively small. There is some damage due to the lowering of grades and quality

of crops, but this has been accounted for in the floodwater damage appraisal. The estimated average annual yield of sediment to the floodplain or damage area is approximately 151,703 tons per year.

The estimated average annual sediment yield to the Pecos River, under future conditions without the project, is 22,645 tons. Concentration of sediment in the total water yield to the Pecos River is estimated at 9,136 milligrams per liter. Some of the sediment will remain in the river channel and some will be deposited in Lake McMillan, approximately 20 miles below the watershed on the Pecos River. Dollar estimates of sediment damage were not segregated from floodwater damage.

DRAINAGE

Adequate drainage facilities have been installed, and with proper maintenance of these facilities drainage is not a problem.

IRRIGATION

The present irrigated area is on deep, highly productive soils. There is no potential for increasing the acreage because ground and surface water is fully appropriated. There can be some transfer of water rights, but no increase. Cropland is irrigated from wells at an average rate of 3.0 acre-feet of water applied annually for each water-right acre. Because of a carriage loss of two inches per acre-foot of water-rights, pumping could be increased to a total of 3.5 acre-feet per acre measured at the well. A small acreage on Cottonwood Creek has surface water-rights. There is no surplus water now nor is any anticipated in the foreseeable future. Existing irrigation systems are generally adequate but need conservation practices that will save water in transit as well as provide for more efficient irrigation water management. Phreatophyte control (saltcedar) has been initiated by the Bureau of Reclamation on the Pecos River as a water salvage project.

MUNICIPAL AND INDUSTRIAL WATER

There is no municipality (city, town, or village) within the watershed project area. There may be some population growth within the project area but there is adequate water for this small growth. If light industry is located in this area, which includes feedlot operations, water rights can be purchased and transferred to this type of enterprise.

RECREATION

Water quality and sediment problems have no serious influence on potential recreation resources within the project area. There is an overall lack of water-related recreational facilities in this area due to the desert climate that prevails over most of the southeast New Mexico.

Water-based recreation within the immediate area of the watershed is extremely limited in relation to the population and apparent need.

McMillan Reservoir, located 20 miles south of the watershed, is an irrigation reservoir which is sometimes dry or very low and is not well-suited for fish production. It has limited use for swimming, water skiing, boating and camping, but no developments or improvements have been made for these purposes at the reservoir.

Present population within a reasonable distance of the watershed is 144,000. The future projected population is expected to reach 200,000 by the year 2000. 1/ Local interest in developing additional resources is extremely keen, and for this reason a water-based recreational area was made a part of this project.

State and local planning agencies have indicated that additional water-based recreational opportunities are needed in southeastern New Mexico. The 1971 Statewide Comprehensive Outdoor Recreation Plan indicates that for the planning area in whcih the project is centrally located, major needs are: tennis courts, developed parks, picnic areas, and boating and fishing areas.

FISH AND WILDLIFE

Maintenance of phreatophyte control project areas, or the expansion of such project areas, will remove tree vegetation, which is important as wildlife habitats. The natural type of habitat along drainageways is periodically flooded, resulting in the destruction of herbaceous and woody vegetation growing in the channel. Following these floods, the channels are often cleaned to remove sediments and debris. Both of these occurrences have the effect of destroying food and cover-producing vegetation which sustains wildlife populations.

The southeastern portion of the state is generally deficient in bodies of water which can be managed for fishing. The area is also deficient in water areas, near croplands, which will provide resting areas for migratory waterfowl during the winter months. The croplands portion of the project area is deficient in providing sufficient winter cover for increases in the pheasant populations.

There are no endangered wildlife species which are resident within the project area. While the ancestral range of the Pecos gambusia (Gambusia nobolis) included this general part of the Pecos River drainage, this endangered species presently does not occur within the project area. 2/

1/ Extracted from New Mexico Bureau of Business Research - August 1972.
2/ "Threatened Wildlife of the United States", 1973 Edition, U.S. Fish and Wildlife Service, and "Endangered Non-game Fishes of the Upper Rio Grande Basin", Clark Hubbs and A. E. Echelle, in proceedings of the Symposium on Rare and Endangered Wildlife of the Southwestern United States, held September 22-23, 1972, Albuquerque, NM.

ECONOMIC AND SOCIAL

The gross income of an average irrigated farm in Chaves and Eddy Counties is presently estimated to be $25,000 per year, and a ranch will gross an estimated $18,000.

Approximately 9 percent of the family-type irrigated farms in the watershed have a gross income of less than $10,000; 21 percent gross $10,000 to $20,000; and 14 percent gross $20,000 to $25,000 per year. The typical ranch in the watershed grosses approximately $16,000.

The median family income presently averages $7,541 for the two-county area in which the watershed is located. This compares to the state average of $7,849 and a $6,438 average for the subarea. 1/

The percent of families now living below the poverty level averages 19.1 percent for Chaves and Eddy Counties, compared with an average of 18.5 percent for the State of New Mexico and 27.9 percent for the Upper Pecos subarea. 1/

The average percent of unemployed workers in Chaves and Eddy Counties increased from 4.1 to 6.4 percent in the period from 1961 to 1971. The unemployment rate for the subarea was 6.0 percent in 1971. During the same period the unemployment rate for New Mexico declined from 6.4 to 4.8 in 1969 and then increased to 6.4 percent by 1971. At the same time, employment in the two counties declined in seven of the 10 major sectors of industry, including agriculture. 2/

A further indication of the level of the economy in this area is that Chaves County is included in the Four Corners Development Area. Eddy County is presently designated by the Economic Development Administration as being an area of chronic unemployment and under-employment (Title IV, P.L. 89-136).

There is a particular need for employment in the construction sector of the two-county area. From 1961 to 1971 the number employed in construction work declined approximately 69 percent. The remaining six sectors which have had a decline in the number employed also need new employment opportunities. These six sectors include:

1. Wholesale and retail trades
2. Mining
3. Transportation, Utilities, Communications
4. Finance, Insurance, Real Estate

1/ 1970 Bureau of the Census Data - "General Social and Economic Characteristics".
2/ Employment Security Commission of New Mexico.

5. Agriculture

6. Other minor sectors

From an estimate of the farms and ranches in the watershed, approximately 7 percent of the private agricultural land is devoted to farms utilizing 1-1/2 man-years or more of hired labor. The remaining 115,000 acres of private farm and ranch land in the watershed is devoted to farms considered to be family-type operations.

There is a need to promote rural community development within the watershed and surrounding area. This is indicated by:

1. Approximately 35 percent of the family-type farms in the watershed gross less than the average family-type operation in Chaves and Eddy Counties.

2. The median family income in Chaves and Eddy Counties is approximately $300 less than the state average.

3. Over 19 percent of the families in the two-county area in which the watershed is located live below the poverty level.

4. The number of agricultural workers in Chaves and Eddy Counties has declined 14 percent over the past decade.

5. The unemployment rate in Chaves and Eddy Counties has increased steadily, by 56 percent, over the past decade.

6. Direct flood damage to agricultural property in the watershed averages $275,200 per year.

PROJECTS OF OTHER AGENCIES

Brantley Dam and Reservoir, a Bureau of Reclamation project, has been authorized. This project will be constructed on the Pecos River about 28 miles below the Cottonwood-Walnut Creek Watershed. The Bureau project will provide for flood control, irrigation water storage, recreation, fish and wildlife. There will be no significant conflict in recreation use between this project and the watershed project since this area of the state is deficient in water-based recreation developments.

The court decree adjudicating land and water rights in the basin ordered the installation of meters on all irrigation wells. This will help to improve irrigation water management.

PROJECT FORMULATION

During the work plan formulation the local sponsors met with local representatives of the Soil Conservation Service, Agricultural Stabilization and Conservation Service, New Mexico State Game and Fish, New Mexico State Park and Recreation Commission, New Mexico State Engineer, and the Bureau of Land Management. The local sponsors established the objectives of providing flood protection to agricultural and urban property, constructing a water-based recreational development project with associated basic facilities, and the protection of watershed lands from erosion and loss of production.

OBJECTIVES

Specific objectives agreed to were as follows:

1. Establish land treatment measures that will contribute to watershed protection and efficient use of irrigation water. Eighty-five percent of the total land treatment needs will be installed by the end of the project installation period.

2. Provide a level of protection to the urban area of Artesia from the 100-year flood event and provide a high level of flood protection to agricultural land. This will include at least a 75 percent reduction in average annual flood damage in the watershed.

3. Establish a water-based recreational development project.

The sponsors will encourage farmers, ranchers, other landowners, and cooperating federal agencies to carry out a complete conservation program on all land within the watershed. The sponsors' goal is to increase the amount of land that is adequately treated from 65 percent to 85 percent during the installation period.

The conservation of irrigation water will be accomplished by the design and installation of more efficient irrigation systems and careful management of water.

The establishment of improved grazing systems on rangeland, with the needed additional fences and livestock water developments, will be encouraged by the sponsors.

Fishing for both warm water and cold water species, additional bird hunting, and boating will be provided by the recreation lake. Improved habitat for upland wildlife, shorebirds, and waterfowl will be provided by the lake and associated park revegetation developments.

Losses of existing high quality wildlife habitats, totaling 6,000 feet along two channels, will be minimized by modification of construction

methods in order to preserve established woody vegetation. Those areas of high quality habitat which will be adversely affected by construction activities will be replanted with selected species of trees.

Another plan objective was improvement of upland wildlife habitats within four floodwater retarding structure sites (4, 6, 7, and 8) primarily by fencing, to exclude livestock. This objective has subsequently been deleted because the sponsors are not able to provide funding for cost-sharing of the fencing.

The level of the project's recreational development for Site 19 will have a designed capacity of 750 visitors at a time on a Sunday during the normal heavy use season. This will include a design capacity of 240 visitors for fishing, 420 for picnicking, and 90 for camping. Public access to the recreational development and basic facilities will be provided. These facilities will be designed for use by the physically handicapped to the extent practicable.

ENVIRONMENTAL CONSIDERATIONS

The project will reduce flood stages on the Pecos River and have some effect on downstream damages. However, due to the relative size of the watershed as compared with the entire Pecos River drainage, downstream damage reduction will be minor and was not evaluated. Sediment reduction from the project area into the Pecos River is significant and has been evaluated.

One of the specific objectives formulated by the sponsors was to provide flood protection from a 100-year frequency flood to an urban area in the north part of Artesia. The objective of providing flood protection to 90 percent of the agricultural lands up to and including the 10-year flood has been achieved and exceeded because of design considerations.

The multiple-purpose structure, Site 19, is the only structure with planned recreation storage capacity. The quality of the water stored at this site will be maintained to provide a suitable habitat for a fishery. Water will be obtained from three artesian wells.

Planning for the recreation lake has included special design features to improve fisheries management and fishing opportunity. Included are deepening of the shoreline area, construction of earthen peninsulars to increase shoreline length adjacent to deep water, and the placement of artificial reefs underwater. The New Mexico State Game Commission and the Department of Game and Fish will exercise control over the surface use of the lake as necessary to protect and enhance wildlife, hunting, and fishing.

The construction methods to be specified for channels will include provisions for preserving sections of channel which contain high quality

wildlife habitats. When the wildlife habitats cannot be preserved the vegetation will be replaced as a mitigation measure.

Consideration was given to preserving and enhancing existing range habitats within the flood pool area of four flood retarding sites. The objective would be to fence out livestock and leave the native vegetation, which would receive increased moisture during periods of runoff, for the benefit of wildlife species. This objective was deleted when the sponsors were unable to provide for their cost-share to construct the necessary fencing.

Presently there is only one farm house, seasonally occupied, that needs to be relocated. This house is located below Site 17A in the floodplain. An irrigated farm has been purchased by the New Mexico State Park and Recreation Commission to secure water and land for the recreational development at Site 19.

The construction stage during installation of the project will cause some localized noise and air pollution problems, and wildlife displacement. The air pollution is mainly dust particles and will be reduced to a minimum by keeping the construction areas moist.

ALTERNATIVES

Land treatment - Consideration was given to land treatment measures for accomplishing the objectives of the local people. These measures would provide needed protection for the watershed. Due to topography and climatic conditions, they would not provide significant reduction in flood runoff and provide only limited reduction in sediment damage. The estimated reduction in sediment yield to the damage area or floodplain from the land treatment program would average about 8,000 tons annually. The land treatment would reduce the average annual yield of sediment to the Pecos River by about 1,200 tons.

Other nonstructural measures given consideration were floodproofing, land use regulation, and relocation of improvements in the floodplain. However, the watershed is an agricultural area and none of the nonstructural measures listed would be feasible or practical measures for protecting agricultural land from flooding.

Flood-proofing the fixed farmstead improvements would be very expensive and would not provide the needed protection to the crops, irrigated cropland, and farm roads. Flood-proofing the urban area in Artesia is possible but the cost of flood-proofing plus the cost of providing flood protection to the agricultural lands in the vicinity is more than the selected plan for this part of the watershed. Likewise, relocation of improvements was eliminated as a viable alternative. Land use regulation would disrupt the farming enterprises. It would be impossible to relocate the farm units along with their respective irrigation systems.

Land treatment, floodwater retarding structures, and floodwater diversions - The floodwater retarding structures and floodwater diversions would control the 100-year storm from the drainage area above the structures. The principal spillway flows and floodwater diversion flows could be discharged into the natural drainage channels. The vegetation or natural stream regime would not be disturbed. The retarded flows would exceed the capacity of the natural channels which would result in flooding and erosion of agricultural lands. The 100-year storm would damage about 2,000 acres, while the 10-year storm would damage about 500 acres. The impacts and benefits of the land treatment program would be realized. The structural measures for the alternative would cost about $7,482,800. This alternative would reduce flood damage by about 80 percent.

Land treatment, channels, and floodwater diversions - This alternative included channel work and floodwater diversions to protect the urban and agricultural lands from the 100-year flood. The channels would require about 354 acres of land rights through the irrigated cropland and about 1,750 acres of land rights through rangeland. The right-of-way would average about 300 feet. About 50 miles of channel would be needed. At least four bridges would have to be enlarged and about 19 new bridges installed. Large concrete drop structures would be needed to reduce the gradient to achieve channel stability. The structural measures for this alternative would cost about $13,240,000. The impacts and benefits of the land treatment would be realized. The sediment yield from the watershed would continue to be transported into the Pecos River. This alternative would reduce flood damage by about 85 percent.

Environmental impacts of the channel and floodwater diversion project without floodwater retarding structures in the watershed would be:

1. Sediment yield to the Pecos River would be increased under future conditions without the project since some sediment would be deposited in the damage area without the channel project.

2. Most of the wildlife habitat on the existing channels would be removed or destroyed by enlarging the channels to the required widths.

3. Farming operations and organizations would be disrupted by constructing the new channels.

4. Flooding potential on the Pecos River would be increased to some extent because flood flows would be directed into the river by the channels.

5. Recreation development benefits would be foregone or would have to be met in other localities.

Land treatment, flood hazard insurance, zoning, and converting agricultural floodplain lands into uses more tolerant to flooding- These alternatives were considered and their impacts analyzed.

Flood hazard insurance for the urban area in Artesia subject to flood damage would need to include the entire floodplain within the city limits. This would include areas damaged by flooding from Eagle-Draw Watershed as well as areas damaged by flood flows controlled by structures on the Cottonwood Creek drainage.

The estimated annual flood insurance premiums for the residential and commercial property located in the floodplain in the City of Artesia is $160,000. This program or alternative would not solve the flood damage to agricultural property, roads, streets, utilities, and the railroad. Sediment yield to the Pecos River would not be reduced. The area of cropland flooded by the 1 percent chance flood (100-year frequency) would be about 6,396 acres, and cropland flooded by the 10 percent chance flood would be 3,657 acres.

Converting highly-developed, irrigated land with irrigation systems into rangeland would create economic and social dislocations in the watershed and surrounding area. Irrigated cropland and the associated improvements have been developed over many years, primarily with private funds. The estimated capital value of approximately 6,396 acres of irrigated land in the floodplain is $5,436,000. This acreage converted to rangeland would have an estimated capital value of about $415,000. This alternative is not feasible nor practical and would create more problems than it would solve.

Flood damage appraisal of the urban area in Artesia included the existing developments and the estimated present worth of further development over the next 20 years. Zoning would have only a limited effect in solving the flood problem because of the existing development. Future development flood damage estimates constitute about 25 percent of the total flood damage appraised in the City of Artesia for future conditions.

The effects of land treatment on sediment yield to the floodplain and Pecos River would be realized and be the same as described in the first alternative (i.e. "Land treatment").

No project - This alternative would include the on-going land treatment program under Public Law 46 and some land treatment impacts would be realized. However, the rate of establishment would be at a lower level than with the proposed project. Under this alternative sediment yield to the floodplain and Pecos River would be reduced. Floodwater damage to agricultural lands and urban areas in the north part of Artesia would remain the same as it is now. Approximately 6,396 acres of irrigated cropland, 100 existing homes, and 10 business firms would be flooded by the 1 percent chance flood. The 10 percent chance flood would inundate about 3,657 acres of irrigated cropland and the urban area of Artesia.

This alternative would not provide flood protection to roads, streets, utilities, and the railroad. No recreational development would be provided.

Formulation of Structural Measures for Selected Plan -
Various alternative combinations of structural locations, structural measures, and levels of protection were investigated. The structural measures presented in this plan were selected for their ability to effectively and economically accomplish the objectives of flood prevention and water-based recreation.

The watershed was divided into two evaluation units. The Cottonwood unit consists of the Cottonwood Creek drainage and the Walnut unit consists of the Walnut Creek drainage.

The retardation of flood runoff by temporary storage on the watershed received first consideration in formulating the system of water flow control measures. The floodwater retarding structures were evaluated by using several alternatives. These alternatives include structures with single-stage principal spillways using reinforced concrete chute emergency spillways, rock emergency spillways, and earth emergency spillways. Structures with two-stage principal spillways were evaluated as an alternative where applicable. The two-stage principal spillway considered storing the standard design storm for the emergency spillway hydrograph, then setting the emergency spillway crest at this water elevation. Various widths for the reinforced concrete chute and rock and earth emergency spillways were considered.

Another alternative evaluated was using a rock or reinforced concrete chute emergency spillway for passing the emergency spillway hydrograph and then setting an earth auxiliary spillway at the water surface of the routed emergency spillway hydrograph. Channel improvements and diversions were considered supplementary to floodwater retardation.

It was decided to proportion all of the floodwater retarding structures to store the volume of runoff from the storm having a one percent chance of occurrence. The overriding factors in depicting this level of control for the agricultural area were the erosive characteristics of soils in the emergency spillway areas and poor climatological conditions for vegetative growth.

During the investigation and project formulation for the Eagle-Tumbleweed Draw Watershed, it was determined that the most feasible method of control for the runoff from the 2.26 square miles of drainage area above and just north of Highway 82 (west of Artesia) was to divert the runoff to a floodwater structure in the Cottonwood-Walnut Creek Watershed. This drainage flows through the municipal airport and then into the northwest and north portion of Artesia. Floodwater Diversion No. 8 was planned just below the municipal airport to collect this runoff and divert it to Structure No. 1. The runoff from this drainage contributes to flooding with floodwater and sediment damages in Damage Area 1 and Area 4 in north Artesia. The damages in Damage Area 1 overlap with damages caused by floodwater and sediment from Eagle Draw.

During the formulation of the project it was determined that land treatment alone would not meet the objectives (75 percent flood damage reduction and a permanent pool at Site 19 for recreation) set forth by the sponsors. As a result, nineteen floodwater retarding structure sites were located for evaluation as potential flood control structures.

In the evaluation process, stream routing studies indicated that structures essential to providing the degree of flood protection set forth in the objectives should be located at: (a) Sites 6, 8, and 19 on the main Cottonwood drainage; (b) Sites 1, 2, 3, and 4 on tributaries to the Cottonwood evaluation unit; and (c) Site 17 on Walnut Creek.

Cottonwood Unit

After comparative cost estimates were made, Sites 6, 8, and 19 were determined to be the most economic combination for floodwater protection on the main Cottonwood drainage. Site 19, however, was determined to have inadequate storage capacity for the uncontrolled drainage area above it, and as a result, Sites 5, 7, 14, and 15 were studied and found to be economical and complimentary to the flood protection afforded by Sites 6, 8, and 19.

Four sites (9, 10, 11, and 12) on the main Cottonwood drainage upstream from Site 19, were studied and found to have less than adequate storage capacity or could not be economically justified. Locations of Sites 9, 10, 11, and 12 in relation to Site 8 are as follows: Site 9 about one mile north, Site 10 about three miles west, Site 11 about four miles west, and Site 12 about five miles west.

Sites 1, 2, 3, and 4 were investigated to determine the effects floodwater retarding would have on the flood damages immediately below them and below Site 19. Sites 1, 3, and 4 were determined to be feasible. Storage capacity at Site 2 was inadequate. Floodwater Diversion 1 (FD-1) was investigated as an alternate floodwater control measure in lieu of Site 2.

An evaluation with established Sites 1, 3, 4, 5, 6, 7, 8, 14, 15, 19, and FD-1 determined the objectives had not been accomplished. FD-2, 3, 7, and 8 were located and investigated for effective floodwater protection in the Cottonwood unit.

FD-2, located between Sites 3 and 4, was investigated and was determined to be the most feasible method of conveying the principal spillway flow from Site 4 and the uncontrolled runoff between Sites 4 and 3. FD-3, located immediately below Site 5 to convey the principal spillway discharge from Site 5 east into FD-2, was investigated as an alternative to Channel 500 and was determined to be more costly than Channel 500.

FD-8 was added to the project when it was determined that Site 1 in the Eagle-Tumbleweed Draw (E.T.) watershed, located just south and adjacent

to Cottonwood, must be relocated upstream. Relocation of Site 1, Eagle-Tumbleweed Draw Watershed, left about 2.3 square miles uncontrolled--which would cause floodwater damages in the City of Artesia and cropland below Sites 1, 3, 4, and 19. FD-8, in conjunction with Sites 1, 3, 4, FD-1, and 2 were determined to be the most feasible combination of flood prevention measures. FD-7 was determined more economical than Channels 1400 and 1500, and provided additional floodwater prevention enroute to the Cottonwood Channel above Site 19. Channels 1400 and 1500 would convey the principal spillway discharge from Sites 14 and 15, respectively, southeast to the natural confluence with Cottonwood channel above Site 19.

Walnut Unit

Four floodwater retarding structure sites were studied on the Walnut Creek tributaries. Evaluation revealed that Site 17 had inadequate storage capacity. The centerline of the proposed structure was then moved upstream a few hundred feet and the site was renumbered 17A. Site 18, 11 miles west of Site 17, was evaluated in series with Site 17, however, it proved to be economically unfeasible. Two other sites--13 and 16--located on tributaries which enter Walnut channel below Site 17, were also studied. Storage capacity at Site 13, located about 3 miles northeast of Site 17A, proved to be inadequate. Two alternate sites, in the vicinity of Site 13, 13A (with FD-4) and 13B (with FD-6) were studied, and it was determined that Site 13B (with FD-6) was the most economical. The study revealed that Site 16, located about 2 miles east of Site 17A, was not feasible.

The evaluation indicates that the most practical and economically feasible combination of floodwater control measures to meet the sponsoring organizations' objectives are: (a) Sites 1, 3, 4, 5, 6, 7, 8, 14, 15, and 19 supported by FD-1, 2, 7, Channels 300 and 500, and Cottonwood channel work from Highway 285 to the Pecos River; and (b) Sites 13B and 17A, supported by FD-6.

WORKS OF IMPROVEMENT TO BE INSTALLED

LAND TREATMENT MEASURES

Practices shown in Table 1 will be coordinated and applied on private and state-leased land in the combinations needed to achieve proper use and adequate treatment. This will be achieved by land operators through complete conservation plans with the applicable Natural Resource Conservation District. On irrigated cropland, this involves the installation of satisfactory irrigation systems so that high efficiency in water application can be achieved. Adequate fences and livestock water facilities are necessary on rangeland before a desirable deferred grazing system can be initiated.

Needed facilities will be identified in conservation plans with the districts and installed by cooperators according to schedule. Land treatment measures that improve wildlife habitat will be encouraged on both cropland and rangeland. Grain sorghum residues and residues from other crops will provide fall and winter food for migratory doves, quail, sandhill cranes, and waterfowl. Improved grazing systems on rangeland will increase the amount of wildlife food.

The Bureau of Land Management, as jointly agreed upon with the sponsors and the Soil Conservation Service, will expand their present management allotment program to encompass a larger part of the watershed. Application of these management allotment plans will improve the vegetative cover on the range and reduce runoff, erosion, and sediment. The combination of these efforts on private, state, and federal land will lengthen the life of the structures and increase the economic condition of farms and ranches by stabilizing and increasing production.

STRUCTURAL MEASURES

Structural measures to be installed include: Eleven floodwater retarding structures; one multi-purpose structure for flood prevention and recreation development with associated basic recreation facilities; five floodwater diversions; and three channels. All disturbed areas will be seeded to grass and will be fenced. Prior to construction archeological investigations and salvage will be made at floodwater retarding structure Sites 7, 8, 13B and 15; multiple-purpose Site 19, and floodwater diversions No. 2, 6, 7, and 8.

FLOODWATER RETARDING STRUCTURES

All of the floodwater retarding structures will be constructed on yielding foundations. The foundation materials range from low plastic clays (CL) to very fine, silty sands (SM). The principal spillways of the 11 floodwater retarding structures will also be built on yielding foundations. They will consist of reinforced concrete pipe conduits, ranging from 24 inches to 60 inches in diameter. The principal spillway inlets planned are single-stage, standard covered risers proportioned to fit the pipe barrel diameters. Energy dissipators will be installed at all the outlets. Inlet risers will be provided with ungated openings, sized to drain the flood volume produced by a 25-year, 6-hour storm, in a maximum of 96 hours. All floodwater retarding structures will have dry pools. The crest of all riser inlets will be placed at the elevation of the anticipated 100-year sediment levels (Table 3).

The floodwater retarding structure at Site 6 will have a concrete emergency spillway. Site 6 will also have an auxiliary earth emergency spillway. Earth emergency spillways will be provided for the structures at Sites 1, 3, 4, 5, 7, 8, 13B, 14, and 15. At Site 17A, the emergency spillway will be excavated in rock. The concrete spillway at Site 6 will be a reinforced concrete chute with a de-energizing basin at the outlet. Any rock obtained from the excavation of emergency spillways will be placed on the outer face or shells of the embankments.

Temporary retarding storage and principal spillway flows in all the floodwater retarding structures will provide control from the runoff produced by a 100-year frequency flood. Initially, control will be greater, because the volume allotted to the 100-year sediment storage will be available for retarding capacity. At Site 8, floodwater retarding storage will be 12,500 acre-feet.

All floodwater retarding structures will be constructed of compacted earthfill obtained at the sites. All sites, except 15 and 17A, have low to high plasticity clay overlying clayey, calcareous gravels (CL, CH and GC).

At Site 15 the embankment materials will be primarily silty, fine sands (SM). Site 17A has large quantities of low plasticity silt with smaller amounts of low plasticity clays and some silty sands available for embankment materials (ML, CL, and SM).

Eighty-five percent of the total watershed area will be controlled by structural measures. Structures in the Cottonwood Creek evaluation unit will control 77.1 percent of the drainage area. The Cottonwood Creek evaluation unit structures consist of floodwater retarding structures at Sites 1, 3, 4, 5, 6, 7, 8, 14, and 15; the multi-purpose structure Site 19; Floodwater Diversion 1, 2, 7, and 8; Channels 300, 500, and Cottonwood Channel. The Walnut Creek evaluation unit consists of structures at Sites 13B and 17A, and Floodwater Diversion 6. These structures will control 86.3 percent of the drainage area. All floodwater retarding structures and floodwater diversions are located on rangeland. The embankments and other disturbed areas will be seeded to grass and fenced to protect the seeded areas.

Existing utilities at all sites will be modified or re-routed to fit site conditions for the planned work. Existing fences within the construction easements will be removed and replaced or relocated by the Sponsoring Local Organization.

Measures to minimize air and water pollution will be followed during construction. Erosion of soil and pollution of the air by dust will be held to a minimum by sprinkling roads in the work area, wetting down borrow areas, use of mulch, vegetation, diversions, traps, and debris basins. Water pollution will be minimized by installing culverts at road crossings and by locating sanitary facilities in areas that will prevent contamination of surface and sub-surface water supplies.

Floodwater retarding structure Site 1 controls a drainage area of 8.93 square miles. It has a total storage capacity of 2,014 acre-feet of which 134 acre-feet is for sediment. Capacity of the 1,400-foot wide earth emergency spillway is the routed class "c" freeboard hydrograph A homogeneous embankment about 4,300 feet long is planned. Borrow materials are located within the sediment pool area and the emergency spillway excavation. Land rights required include 353 acres of construction

easements, about 170 acres of flowage easements, and 1 subordination agreement.

Floodwater retarding structure Site 3 controls 13.57 square miles of drainage. It has a total storage capacity of 2,043 acre-feet of which 285 acre-feet is for sediment storage. A 1,400-foot wide earth emergency spillway on the right abutment is planned at this site. It is proportioned to pass the routed class "c" freeboard hydrograph without over-topping the dam. A homogeneous embankment about 6,850 feet long with a maximum height of 23 feet is planned. Borrow materials will be obtained from the sediment pool area and the earth emergency spillway excavation. Land rights required include about 355 acres of construction easements, about 120 acres of flowage easements, and 2 subordination agreements. About 26 acres of farm land will be under water during passage of the emergency spillway hydrograph.

Site 4 controls 10.71 square miles of drainage. It has a total storage capacity of 1,310 acre-feet. One hundred eighty (180) acre-feet of this storage is for sediment. An earth emergency spillway with the capacity to pass the class "b" routed freeboard hydrograph is planned. The length of the planned embankment is about 7,700 feet. Borrow for a homogeneous embankment will come from the sediment pool area. Approximately 340 acres of construction easements, 60 acres of flowage easements, and 2 subordination agreements are the required land rights.

Site 5 controls 10.25 square miles of drainage. It has a total storage capacity of 1,103 acre-feet. The anticipated 100-year sediment volume is 155 acre-feet. The 1,000-foot wide earth emergency spillway will have the capacity to pass the class "c" routed freeboard hydrograph. A homogeneous embankment about 6,400 feet long is planned. Borrow materials will come from the earth emergency spillway excavation and from the sediment pool area. Land rights required include about 310 acres of construction easements and 80 acres of flowage easements, all of which are on rangeland.

Floodwater retarding structure Site 6 controls 42.03 square miles of drainage. It has a total storage capacity of 3,420 acre-feet. The anticipated 100-year sediment volume is 670 acre-feet. The earth spillway crest is set above the water level elevation of the routed class "c" emergency spillway design hydrograph which passes through the 100-foot wide concrete chute spillway. Capacity of both spillways is the routed class "c" freeboard hydrograph. Approximately 1,650 cubic yards of concrete will be required for the chute. Borrow materials for the homogeneous embankment, approximately 10,400 feet long, will come from the earth emergency spillway excavation. Land rights on rangeland include approximately 1,030 acres of construction easements, 290 acres of flowage easements, and 2 subordination agreements.

Site 7 has a drainage area of 6.89 square miles. It has a total storage capacity of 826 acre-feet. One hundred forty acre-feet of this storage is for the calculated 100-year sediment volume. The earth emergency spillway has the capacity to pass the routed class "c" freeboard hydrograph. Earthfill for the embankment will come from the earth emergency spillway excavation and from the sediment pool area. The embankment is approximately 2,000 feet long. Land rights required are approximately 190 acres of construction easements, about 15 acres of flowage easements, and a subordination agreement.

The area controlled by Site 8 is 59.65 square miles. It has a total storage capacity of 13,414 acre-feet, with 988 acre-feet for the anticipated 100-year sediment volume. The 1,100-foot wide earth emergency spillway will have the capacity to pass the routed class "c" freeboard hydrograph. Length of embankment is approximately 8,200 feet. It is a homogeneous fill to be constructed from borrow materials excavated from the earth emergency spillway and from the borrow area within the sediment pool. Land rights include approximately 700 acres of construction easements, about 430 acres of flowage easements, and 4 subordination agreements.

Site 13B controls 24.06 square miles of drainage area in the Walnut unit. It has an earth emergency spillway with the capacity to pass the routed class "a" freeboard hydrograph. The total storage is 2,613 acre-feet with 300 acre-feet for the anticipated 100-year sediment volume. A homogeneous embankment approximately 7,400 feet long with a maximum height of 12.3 feet is planned at this site. Borrow material is available just upstream from the embankment and close to the existing natural depressions. Land rights on rangeland include approximately 660 acres of construction easements, 310 acres of flowage easements, and 2 subordination agreements.

Site 14 controls a drainage area of 4.54 square miles within the Cottonwood unit. It has a total storage capacity of 494 acre-feet of which 72 acre-feet are for the 100-year sediment volume. Capacity of the earth emergency spillway is the routed class "c" freeboard hydrograph. A homogeneous embankment approximately 5,400 feet long is planned. Excavation materials from the earth emergency spillway and from the sediment pool area are to be used to construct the embankment. Land rights include approximately 236 acres of construction easements and about 60 acres of flowage easements. Subordination agreements are required for two utilities, a gas pipeline, and a county road. They will be re-routed around the site.

Site 15 has a drainage area of 4.62 square miles and a storage capacity of 554 acre-feet. The 100-year sediment storage volume is anticipated to be 72 acre-feet. A low homogeneous embankment approximately 4,200 feet long is planned. Fill material is available from the earth emergency spillway and the valley area upstream from the embankment. Capacity of the earth spillway is the routed freeboard class "c" hydrograph. Approximately 213 acres of construction easements and 60 acres of flowage

easements are the required land rights. A subordination agreement for future county roads along section lines is also needed.

Site 17A controls 68.15 square miles of the watershed. It has a storage capacity of 5,477 acre-feet with 845 acre-feet for sediment storage. The 700-foot wide emergency spillway is cut through a hill which has rock at the crest elevation. Exposed earth sides will be protected with a soil cement stabilizer, 100-feet wide, which forms a hard, durable section with the rock bottom. The spillway has the capacity to pass the routed freeboard hydrograph. A zoned embankment is planned using borrow materials from the emergency spillway excavation and the area just upstream from the embankment. It will be approximately 6,000 feet long and about 49 feet high. Land rights on rangeland include approximately 562 acres of construction easements, about 486 acres of flowage easements, and 2 subordination agreements. A seasonally occupied house, about 1,800 feet downstream from the embankment centerline, will be moved away from the site.

MULTIPLE-PURPOSE STRUCTURE

Site 19 has a total storage capacity of 4,150 acre-feet with 1,143 acre-feet for the permanent recreation pool, 540 acre-feet for submerged sediment, 77 acre-feet for aerated sediment, and 2,390 acre-feet for floodwater retardation (Table 3). Sites 5, 6, 7, 8, 14, and 15 are in series with, and upstream from, Site 19. These structures control 127.98 square miles of the 156.39 square miles of drainage area upstream from Site 19.

The Site 19 embankment foundation consists of compressible materials (silt and silty clay ML-CL) from 5 to 10 feet thick. These beds overlie preconsolidated sand and gravel, weathered sandstone bedrock, and conglomerate. A reinforced concrete box will be used as the principal spillway. The concrete box riser will be installed at the permanent recreation pool elevation. In addition, a gated reinforced concrete drainpipe will be installed to drain the permanent pool when required. A reinforced concrete inlet structure will be attached to the drainpipe. A maximum principal spillway discharge of 1,500 cubic feet per second for storms up to and including the 100-year event must be maintained.

A gravity section approximately 400 feet wide is planned as an emergency spillway at this site. The gravity section will be constructed from soil cement with a two-foot thick reinforced concrete cap extending from crest elevation to the end of the outlet floor. The gravity section, with a soil cement base about 56 feet by 400 feet, will rest on bedrock that exists in the foundation approximately 15 feet below channel bottom. Upstream from the gravity section a soil cement approach channel with reinforced concrete side walls is planned. The gravity section and outlet side walls will also be reinforced concrete. Downstream from the concrete outlet, rock riprap is planned. The 2.5 foot thick riprap will extend for about 45 feet downstream from the end of the outlet. The principal

spillway box culvert will pass through the gravity section and discharge into the concrete outlet.

Approximately 21,250 cubic yards of soil cement and 2,990 cubic yards of reinforced concrete will be required for the spillway system. Retarding storage and principal spillway discharge will provide control of runoff from the 100-year frequency flood for uncontrolled areas upstream from Site 19. The emergency spillway capacity is the routed class "c" freeboard hydrograph.

Fill materials available for the embankment are clayey silt (CL), silty clay (ML), and silty sands (SM). This material will be used to install a zoned embankment approximately 2.4 miles long with a maximum height of about 48 feet. The upstream 3:1 slope will have a 10-foot berm. The berm will be 2.0 feet below the permanent pool elevation. Slope protection to prevent wave erosion will be provided 5.0 feet above and 2.0 feet below the permanent pool elevation. The downstream slope will be 2.5:1. A 1,200 foot cutoff trench extending approximately 25 feet below the channel is planned. All the compressible material in the foundation upstream from the spillway will be removed. Additional foundation excavation in the valley portion of the embankment is also planned.

Cut and fill along the permanent pool shoreline is planned to increase the water depth. Blanketing critical areas with impervious material is planned to reduce seepage losses from the permanent pool.

The reservoir area will be cleared of existing fences, buildings, trees, and brush. The reservoir is designed for a 100-year life. The principal spillway crest is established at the elevation of the permanent recreation pool. Below this elevation, 540 acre-feet are allotted for submerged sediment but will initially store water. Two continuous water metering or measuring devices will be installed at this site. One is planned upstream from the dam and the other will be located immediately downstream from the dam. Needed land rights include approximately 576 acres of construction easements, 6 acres of flowage easements, and 3 subordination agreements.

The basic recreation facilities will be located immediately upstream from the dam and on the west side of the reservoir at Site 19. They will be on compacted fill that is a minimum of two feet above the emergency spillway crest elevation. The recreational facilities will include picnic and camping units, sanitary facilities, and facilities for boating. Fishing, hunting, and boating will be available in the permanent pool. Boating will be limited to sailboats, those that are self-propelled, and those with electric trolling motors only. The recreational area will be landscaped with grass, shrubs, and trees. These will be irrigated from a well which is to be drilled for the basic facilities water supply and for irrigation of grass and trees established at the site. The recreation development, including Site 19 dam and reservoir and the

associated basic facilities, will be a state park. The picnic units will also be utilized for overnight camping. There will be two picnic and overnight camping areas with 30 units in each. The recreational facilities will be designed to provide access, use, and safety for physically handicapped persons. The area required for the dam and reservoir is 348.4 acres. The basic recreational facilities require 184.3 acres. The permanent pool in the reservoir area will cover a maximum of 150 acres under optimum conditions of water supply and will have a volume of 1,143 acre-feet. Exterior fences to protect the development will be installed around the basic recreational facilities and the dam.

About 1.3 miles of road will be constructed into the recreational area from existing State Road 350. Parking areas will be provided for the users of the 60 camping and picnicking units. Parking areas for 50 cars and boat trailers will be provided for fishermen using the recreation reservoirs.

Sanitary facilities will include a central unit comfort station as well as chemical toilets to serve a secondary picnic-camping facility. The comfort station will have flush toilets and lavatories. Liquid wastes will be disposed of by a septic tank and sub-surface disposal system. Facilities will meet state public health standards.

FLOODWATER DIVERSIONS

The five floodwater diversions (about 73,400 feet) are planned to transport the peak flow produced by a 1 percent chance storm (100-year frequency). A freeboard of 2 feet is planned above that water surface.

Floodwater Diversion No. 1 will transport the principal spillway discharge from Site 1 into Site 3. It will control 7.30 square miles of drainage by diverting the flows into Site 3. Materials at the upper end consist of low plasticity clays (CL) and in the lower reaches clayey silts and silty clays (CL-ML). The diversion will be constructed across rangelands where no channel exists. From station 51+00 to station 102+00 planned capacity consists of the peak flow from a 0.26 square mile drainage area. From station 102+00 to station 218+00 diversion capacity is the peak flow from the drainage area, about 7.04 square miles, between Site 1 and Site 3. A pre-positioned overflow section will be located approximately at station 115+00 just past the main draw. Land rights needed include approximately 280 acres of construction easements, 130 acres of flowage easements, and two subordination agreements.

Floodwater Diversion No. 2 will transport the principal spillway discharge from Site 4 into Site 3. It will control 0.42 square miles of drainage by diverting flood flows into Site 3. The diversion channel bottom is on hard caliche-type rock (GC). Excavation will be through low plasticity clay (CL) varying in depth from grade to three feet. The

diversion is located on rangeland. Approximately 130 acres of construction easements, about 30 acres of flowage easements, and 1 subordination agreement will be required.

Floodwater Diversion No. 6 will transport the principal spillway discharge of Site 13B to Walnut Channel. It will control 3.97 square miles of drainage by diverting flood flows into Walnut Creek. The diversion will be on rangeland. Materials include low plasticity clays (CL) to sandy silts (SM) with some gravelly sands (SP-SM). A reinforced concrete structure with training dikes will drop the floodwater into Walnut Creek (see Table 3B). At station 232+00, approximately, a county road crossing will be installed. Gated conduits (weeps) will be provided at stations 93+00 and 199+50, approximately, to allow some of the floodwater to flow in its natural course. The maximum discharge will be about 10 cubic feet per second. Required land rights include 500 acres of construction easements, 120 acres of flowage easements, and 3 subordination agreements.

Floodwater Diversion No. 7 will transport the principal spillway discharges of Site 14 and Site 15 to Cottonwood Creek. In addition, it will control 0.95 square miles of drainage by diverting flood flows directly into Cottonwood Creek. This diversion will be installed on rangeland, through mostly low plasticity clays and gravelly clays, underlain by hard, caliche-type rock at varying depths from 2 feet to 7.5 feet. A gated conduit (weep) will be provided at about station 22+00 (Site 15 draw) to allow some of the floodwater to flow into its natural course. The maximum discharge will be approximately 10 cubic feet per second. A road crossing will be installed where the diversion crosses a county line road. Required land rights include 377 acres of construction easements, 50 acres of flowage easements, and 4 subordination agreements.

Floodwater Diversion No. 8 will control 2.26 square miles of drainage area by transporting the floodwater into Site 1. The diversion channel will be excavated mostly in materials consisting of low plasticity clays (CL), some being gravelly, and a short section of clayey gravels (GC). Land rights include 240 acres of construction easements, 10 acres of flowage easements, and five subordination agreements. Road crossings will be installed where the diversion crosses U.S. Highway 82 (approximately at station 151+00 and at the airport road (approximately at station 168+00). An overflow section will be placed just downstream from the main draw (approximately at station 213+00).

CHANNEL WORK

Approximately 9.7 miles of channel construction and improvement involving three channels are included in the works of improvement (Table 3A and Figure 6).

Channel 300, about 18,500 feet long, will transport the principal spillway discharge of Site 3 from the dam to the floodplain of Cottonwood Creek. There is no existing channel. The new channel will be constructed mostly through irrigated cropland. It will be through materials consisting of low plasticity clays (CL) from 3 to 12 feet deep, where a layer of slightly clayey sand and gravel from 1.0 foot to 2.8 feet thick is found along part of the channel.

Drop spillway structures requiring approximately 588 cubic yards of reinforced concrete are to be installed for channel stabilization. Two will be installed in conjunction with culverts and turn structures at station 182+60 (13th St.) and station 259+67 (County Road west of old Highway 285), and one in conjunction with a culvert and rectangular concrete channel at station 275+00 (A.T. & S.F. Railroad). A low-water road crossing is to be installed at station 130+00 (26th Street).

Slope protection will be provided at the turn located at station 196+50. It will require approximately 205 cubic yards of rock.

Side drain inlet structures will be provided as needed. Existing irrigation facilities crossing the planned channel will be modified and reconstructed.

Land rights requirements include 190 acres of construction easements and 17 subordination agreements where existing utilities, roads, a pipeline, and a railroad cross the planned channel. Existing utilities and the pipeline will be modified to accommodate the channel.

Channel 300 includes approximately 200 feet of high value wildlife habitat which will be preserved by aligning the channel to avoid damage to the habitat. Any accidental damage to the habitat will be mitigated by planting selected species of trees.

Channel 500 will transport the principal spillway discharge of Site 5 to Cottonwood Creek. It will follow the existing natural channel for about the first 1,500 feet. Thereafter it will be realigned and a new channel excavated through rangeland. The first 2,000 feet will be constructed in caliche gravel. The remainder will be in alternating segments of caliche gravel and gravelly soils (CL-ML) with indurated caliche gravels at the exit into Cottonwood Creek. Approximately 67 acres of construction easements and one subordination agreement are the required land rights.

All weather road crossings will be provided at stations 20+00 and 51+00. A flume will be installed at station 21+00 where the channel intersects an existing concrete-lined ditch. Standard drop structures will be constructed at approximately stations 21+00 and 69+00. They will require about 80 cubic yards of reinforced concrete (see Table 3B).

Cottonwood Channel begins at a point approximately 3,000 feet downstream from U.S. Highway 285 (Station 678+00). It follows the existing creek from this point to Station 880+00, which is about 2,000 feet downstream from the intersection with Alternate U.S. Highway 285 and the railroad. This portion of the channel will be improved and proportioned to carry the routed 100-year peak flow from the drainage area below Site 19 plus the 100-year principal spillway flow from Site 19.

From Station 880+00 to the Pecos River (Station 936+00) a new alignment direct to the river will be followed. Capacity for this section will be the 100-year principal spillway outflow from Site 19.

Materials along the channel banks from about Station 678+00 to Station 895+00 consist of low plasticity, slightly calcareous clay. The creek bottom from Station 530+00 to Station 655+00 consists of hard limestone conglomerate. From Station 655+00 to approximately Station 840+00 the creek bottom consists of materials varying from sands (SW) to gravels (GW). From Station 840+00 to the Pecos River materials consist of low plasticity clays (CL).

Several grade stabilization structures are planned (see Table 3B). Upstream from the first structure at Station 678+00, diking will be required to direct flows to the structure.

Land rights include 336 acres of construction easements and 14 subordination agreements where utilities, roads, a railroad, and pipelines cross the channel. Side drain inlets will be provided to allow local runoff to enter the channel. A low water road crossing will be provided at Station 815+00 (County Road). Minor work will be done, reinforcing and underpinning the existing railroad and road bridge piers and abutments.

Cottonwood Channel contains an aggregate total of approximately 5,800 feet of high value wildlife habitat, which will be preserved by channel realignment or excavating only one side of the existing channel. Any wildlife habitat destroyed or adversely affected by channel work will be replanted with selected species of trees.

EXPLANATION OF INSTALLATION COSTS

The total estimated cost of project installation is $12,055,100. The costs of individual segments of this project are shown below.

The estimated cost of installing land treatment measures is $2,254,500. This figure includes $8,100 for federal land on which the Bureau of Land Management will develop a management plan for the operating unit. Approximately $32,500 will be spent by ranchers without cost-sharing on scattered tracts of federal land within their operating units. On non-federal land, farmers and ranchers will spend about $2,078,900 for land treatment. Cost-sharing on these lands may be available from the Great

Plains Conservation Program and the Rural Environmental Conservation Program for permanent-type conservation practices.

The estimated cost of Soil Conservation Service technical assistance provided through the Natural Resource Conservation Districts amounts to $135,000. This will be used for planning and application on private, state, and Class A federal land. The Soil Conservation Service will provide about $52,700 of this amount from regularly appropriated funds for assistance to districts; the remaining $82,300 will be from Public Law 566 funds to accelerate technical assistance to farmers and ranchers in applying land treatment measures on private and state land.

The total estimated installation cost of the structural measures and basic recreational facilities included in the plan is $9,800,600. This cost includes costs of construction, engineering, land rights, water rights, archeological salvage, and project administration. A tabulation of cost items for each structure is included in Table 2 of this plan.

Construction costs are the engineering estimates for construction and include a contingency allowance of 12 to 20 percent to provide for unforeseen costs on the structural measures described. Construction costs, estimated to be $7,577,100, include the contract or force account cost for constructing structural measures, basic facilities, and the following:

1. Reinforcing, underpinning, or reconstructing existing railroad and public road bridge piers and abutments necessitated by modification of the channels.

2. Clearing of sites for project purposes.

3. Construction of necessary structures to provide controlled inlets into the project channels.

4. Alteration, modification, or reconstruction of existing irrigation facilities made necessary by project works of improvement.

5. Providing needed travelways for maintenance along improved project channels including necessary culverts and fords.

6. The disposal of waste spoil in accordance with sound engineering design and construction principles.

Included under engineering costs, estimated to be $502,000, are the direct costs of engineers and other technicians for surveys, investigations, design, and preparation of plans and specifications for structural measures.

The cost of land rights includes all costs for the following items:

1. All expenditures made in acquiring land, easements, leases, and rights-of-way or their value as estimated by the local organization with the concurrence of the Service.

2. Removal of buildings or improvements for salvage or relocation.

3. Changes of existing telephone, power, and gas lines or other utilities.

4. All new and changes of existing public or private road or railroad bridges, culverts, and other crossings including approaches, except reinforcing, underpinning or reconstruction of existing bridge piers and abutments necessitated by modification of channels.

5. All relocations and changes of highways and roads that are to remain serviceable after project installation.

6. Relocation or reconstruction of existing fences made necessary by construction and not needed for the proper operation, maintenance or inspection of the works of improvement.

The costs of the land rights included in the work plan are estimated to be $322,400. This includes $25,600 for relocation of utilities; $80,900 for relocation of roads and bridge construction; $9,800 for reconstructing fences; $3,000 for relocation of a seasonally-occupied house; and $203,100 for other land rights costs including land, easements, rights-of-way, and legal surveys. (Details on cost and elements of land rights are shown in Table 2.)

Project administration costs are estimated to be $998,200, of which $988,700 are Public Law 566 costs and $9,500 are costs to be borne by other funds. The Public Law 566 costs of project administration include $612,300 for inspection during construction and $376,400 for all overhead costs of installing the structural measures. The cost of project administration to be paid with funds other than Public Law 566 are $9,500 for contract administration and other administrative cost incurred by the local sponsoring organizations in the installation of project measures.

Public Law 566 funds include the payment for the costs of:

1. All construction costs allocated to flood prevention.

2. Fifty percent of the construction costs allocated to recreational development.

3. All engineering costs except those engineering services associated with the basic recreational facilities at Site 19, for which P.L. 566 funds will bear 50 percent of the payments made for required private engineering and architectural services.

4. Fifty percent of the land rights costs on multiple-purpose structure Site 19 and the basic recreational facilities excluding legal, administrative, land survey, and flowage easement costs.

5. All Public Law 566 administrative costs.

Other funds will bear the cost of:

1. Fifty percent of the construction costs allocated to recreational development.

2. Fifty percent of the payments made for private consulting engineering and architectural services required for the basic recreational facilities.

3. All costs for securing water rights and required water metering facilities.

4. All costs for legal, administrative, and land rights surveys for acquiring land rights.

5. All costs for acquiring land rights except for cost-sharing with Public Law 566 funds on Site 19 and basic recreational facilities as previously described.

6. Fifty percent of the land rights cost for Site 19 and basic recreational facilities.

7. All local administration costs.

8. The cost of stocking the reservoir at Site 19 with fish.

9. The cost of installing streamflow measuring devices at Site 19.

10. The cost of archeological investigation and salvage.

The joint costs of Site 19 (multi-purpose) were allocated to flood prevention and recreation by application of the "use of facilities" method of cost allocation.

Recreation Storage	1,143 acre-feet =	27.5%
Floodwater Detention and Sediment Capacity	3,007 acre-feet =	72.5%
TOTAL	4,150 acre-feet =	100.0%

Land rights costs, excluding flowage easement, for the dam and reservoir were allocated to recreation. The cost of flowage easements were allocated to flood prevention. The following tabulation shows the allocation of costs by purposes:

Item	Flood Prevention 72.5%	Recreation 27.5%	Total
	$	$	$
Site 19 - Multiple-Purpose Structure			
Joint Costs			
1. Dam and Reservoir:			
(a) Construction	951,000	360,700	1,311,700
(b) Engineering	57,100	21,600	78,700
2. Archeological Salvage	2,600	1,000	3,600
Specific Costs			
1. Shoreline Shaping and Pool Deepening			
(a) Construction	--	72,200	72,200
(b) Engineering	--	4,300	4,300
2. Reservoir Blanketing			
(a) Construction	--	18,000	18,000
(b) Engineering	--	1,100	1,100
3. Water Rights	--	380,900	380,900
4. Land Rights			
(a) Fee Simple Title	--	17,400	17,400
(b) Flowage Easements	100	--	100
(c) Legal Fees, Surveys	--	500	500
5. Stocking Reservoir with Fish	--	10,000	10,000
6. Streamflow Measuring Devices	--	8,000	8,000
TOTAL	1,010,800	895,700	1,906,500

The cost of the structural measures to the federal government and to the local sponsoring organizations will be based upon the actual constructed quantities. The cost-sharing summaries shown in the work plan are the best estimates available during the planning stage of project development.

The estimated schedule of obligations for the installation of land treatment and structural measures during the installation period is shown in the following tables.

ESTIMATED FUND OBLIGATIONS

By Years

LAND TREATMENT

Year	P.L. 566 Funds	Other Funds	
		Bureau of Land Management	Other Sources
First	10,200	1,000	270,500
Second	10,200	1,000	270,500
Third	10,200	1,000	270,500
Fourth	10,200	1,000	270,500
Fifth	10,200	1,000	270,500
Sixth	10,200	1,000	270,500
Seventh	10,200	1,000	270,500
Eighth	10,900	1,100	270,600
TOTAL	82,300	8,100	2,164,100

STRUCTURAL MEASURES

Year	P.L. 566 Funds	All Other Funds
First	$ 500,000	$ 320,000
Second	500,000	200,000
Third	1,200,000	200,000
Fourth	1,200,000	74,400
Fifth	1,500,000	73,800
Sixth	1,000,000	73,800
Seventh	1,000,000	73,800
Eighth	1,811,000	73,800
TOTAL	$8,711,000	$1,089,600

THE EFFECTS OF WORKS OF IMPROVEMENTS

FLOOD PREVENTION, EROSION, AND SEDIMENT

The structural measures included in this plan will reduce average annual flood damage in the watershed by about 91 percent and control runoff from 85 percent of the watershed area.

The October 1954 flood on Cottonwood Creek had a frequency equal to the one percent chance of occurrence. Areas flooded on Cottonwood Creek with and without the project are shown in the tabulation in this section

(see "Summary of Irrigated Cropland Flooded"). Under present conditions, peak flow from a flood having a one percent chance of occurrence on Cottonwood Creek is 17,700 cubic feet per second (c.f.s.) at the U.S. Highway 285 bridge. With the project installed, the flow at this point will be reduced to 1,500 c.f.s. from the same frequency flood. The flood of June 13, 1964, on the lower end of Cottonwood Creek, resulted in 1,896 acres of farm land being damaged, and approximately $167,500 of urban damage. Flood routing indicates there will be no significant remaining damage in Damage Areas 1 and 4 with the project installed.

Had the project been installed, only 510 acres of farm land would have been flooded by the June 1964 flood in the lower end of Cottonwood Creek. This would have been a reduction of 73 percent in the area inundated. No damage to urban property other than roads and streets would have occurred. The damage per acre would also have been less with the project installed due to decreased depths of flooding.

From the July 29, 1965 flood, 1,388 acres of farm land were flooded along Walnut Creek and its tributaries. With the project installed, the area flooded from this size flood will be reduced to 217 acres. On Walnut Creek at the Alternate U.S. Highway 285 bridge, flow from a flood having a one percent chance of occurrence will be reduced from 10,200 c.f.s. to 3,400 c.f.s. with the upstream structural measures installed. The remaining damages will be to 57 acres of irrigated land immediately west of the highway.

SUMMARY OF AREAS OF IRRIGATED CROPLAND FLOODED

Evaluation Unit	Acres Inundated by Percent Chance of Occurrence				
	70%	50%	10%	4%	1%
Cottonwood Creek					
Without Project	Damage Begins	60	2,656	3,920	4,832
With Project	0	0	211	732	1,193
Walnut Creek					
Without Project	0	Damage Begins	1,001	1,394	1,564
With Project	0	0	48	413	522

Indirect damage such as interruption of travel, loss of time from regular employment to repair flood damage, and the general nuisance and inconvenience caused by floods will be greatly reduced.

The land use in the floodplain of the watershed is entirely agricultural other than roads, highways, and the railroad. Major crops are cotton and alfalfa. Other crops grown include grain sorghum, corn, vegetables, and small grains. With the project installed it is anticipated that some additional acreage will go out of alfalfa to vegetable crops.

Under future conditions without the project it is estimated that the average annual agricultural land flooded would be about 1,200 acres. The estimated average annual crop loss and damage would amount to $237,200. With the project installed the area inundated would be reduced to approximately 100 acres with an average annual damage of $23,900.

Without the project an estimated 151,703 tons of sediment is deposited annually in the damage area of the watershed. With the project installed sediment deposition in the damage area will practically be eliminated. Sediment yield to the Pecos River will be reduced from 22,645 to 12,425 tons annually by the project. The concentration of sediment in water from the watershed will be reduced from 9136 to 5012 milligrams per liter and will result in minor improvement in water quality to the Pecos River.

Approximately 50 farm owners and operators on about 6,000 acres of irrigated cropland will directly benefit from the project. In addition, the project will provide protection to an urban area in Artesia which adjoins the watershed. About 630 acres of urban land with approximately 100 homes and 10 business properties will be protected from floods up to and including the one percent chance of occurrence flood. Flood damage in the urban area from floods larger than the one percent chance of occurrence flood will still occur after the project is installed. These damages were not evaluated. Agricultural damage will be reduced by about 91 percent and urban damages by about 100 percent from floods up to and including the one percent chance of occurrence floods.

The installation and operation and maintenance of the project measure will provide employment for unemployed and underemployed people in the project area. It is estimated that about 25 man-years of local labor will be used annually over the expected eight years of project installation. In addition, the operation and maintenance of project measures will provide for about 3 man-years of employment annually.

FISH AND WILDLIFE AND RECREATION

Construction of five floodwater diversions totaling about 13.9 miles will not have any significant adverse effect on the rangeland habitats where they are planned. Construction of three channels totaling about 9.7 miles will have a negative impact on existing wildlife habitats within portions of two channels. Channel 300 contains 200 feet of high quality wildlife habitat and Cottonwood Channel contains 5,800 feet. Portions of the high quality habitat will be preserved through modifications in construction methods, i.e., excavation of only one side of the drainageway, or by channel realignment. All wildlife habitat destroyed will be replanted with selected trees and shrubs. The lower section of the Cottonwood Channel, below the AT&SF Railroad tracks, will divert flood flows directly to the Pecos River bypassing a natural channel which now flows in a southerly direction. There are remnant stands of saltcedar

along the existing southerly channel. There is sufficient ground water available to sustain this vegetation after the new channel is constructed. There will be no other wetlands affected by the project.

The reduction of flood flows in the natural drainageways below the floodwater retarding structures will prevent the washing out of naturally occurring vegetation. The prolonged release of water from floodwater retarding structures will increase the growth and distribution of vegetation in downstream drainageways. The beneficial effects of this improved cover will, however, be largely lost to wildlife use due to grazing by livestock. There will be an insignificant acreage of rangeland habitat-type destroyed in the construction of floodwater retarding structures and floodwater diversions. The effects upon wildlife using this habitat type is of little consequence. There will be no effects upon aquatic life. There are no endangered wildlife species in the project area. 1/

The new state park will include a recreation lake with an average surface area of 120 acres that will provide fishing, boating, wildlife viewing, hunting, field sports, picnicking, and camping. The recreation season will be year-round for most activities. The 60 camping and picnic units will be used primarily for picnicking in the daytime and camping at night.

The daily design capacity of the recreational development is approximately 750. This includes 240 fishermen, 420 picnickers, and 90 campers. Hunting will be seasonal and primarily in the fall and winter months. The estimated annual visitations to the site is 63,970, which includes 18,800 for fishing, 470 for hunting, 12,800 for camping, 31,800 for picnicking, and 100 for boating.

Public access to the recreational development will be provided on a year-round basis. The New Mexico State Park and Recreation Commission has purchased the land and water rights in connection with development of the recreation site (Site 19 with basic recreation facilities).

ARCHEOLOGICAL, HISTORICAL, AND SCIENTIFIC

A field investigation and evaluation has been made by the Museum of New Mexico. The report by the Museum of New Mexico lists archeological and historical sites that will be affected by installing the following works of improvement: (a) floodwater retarding structure sites 7, 8, 13B, and 15, Site 19; and (b) floodwater diversions 2, 6, 7, and 8.

None of the archeological/historical sites warrant being listed in the National or State Registers of Historic Places. However, further investigation of at least some of the sites is warranted prior to construction of structural works of improvement. This will provide a record of the contents of early prehistoric and early historic settlements in the area. Mitigation of the adverse effects of project installation on archeological and historic sites will be accomplished by excavation and salvage prior to construction. This work will be carried out by archeologists from the National Park Service.

1/ "Threatened Wildlife of the United States", 1973 Edition, U.S. Fish and Wildlife Service.

To minimize adverse effects of project installation on archeological/ historical sites, the Museum of New Mexico has recommended excavation of several identified prehistorical and historical sites. Relocation of flood prevention works of improvement is not warranted. 1/

ECONOMIC AND SOCIAL

The economic base of the area essentially consists of agriculture, mining, petroleum production, some manufacturing, services, wholesale and retail trade, transportation and public utilities, and a small amount of construction. The 1970 per capita income within the watershed is estimated to be approximately the same as the average of Chaves and Eddy Counties, or about $2,600. This compares with the state average of $2,848, and the national average of $3,698. 2/

It is felt that the distribution of the rural population within the watershed will remain relatively constant. The quality of life in the watershed will be improved by the project. Higher farm income per farm, a feeling of security from flooding, and the ability to constantly improve the land without setbacks from flooding will improve living conditions in the watershed.

Rural development in general will be advanced by the project. This advance will be brought about by:

(1) Cost savings by flood prevention.

(2) Increased efficiency of farm operations.

(3) Higher farm income.

(4) Greater security.

(5) Improved rural living.

(6) Improved aesthetic values.

(7) Preservation of open space.

(8) Increased tax base.

(9) Increased farm values.

(10) Higher quality farm products.

(11) Incentives for future generations to remain on the farm.

1/ An Inventory of Archaeological and Historical Remains in the Cottonwood-Walnut Drainage, Chaves and Eddy Counties, New Mexico - August 1974 (Museum of New Mexico).

2/ 1971 Statistical Abstract - Personal Income, Dept. of Commerce.

(12) Improved environment for migratory waterfowl, songbirds, game birds, and mammals.

It is estimated that the project will not have major secondary effects on the regional economy. However, secondary benefits will be significant in the watershed and in the nearby trade area.

The efficiency of agriculture will be improved by the project. Crops can be planted with confidence at earlier dates. The possibilities of replanting will be significantly reduced, thereby saving added costs of production and releasing labor for other work. Delayed harvesting due to flooding will be reduced and the risk of having to harvest immature crops due to the lateness in the season avoided.

This project will expand the rural economic base. Direct average annual agricultural benefits of $251,300 actually will be a form of cost savings that releases income for needed goods and supplies that could not be afforded previously. Making additional income available in this manner will in turn generate other income in the community and immediate trade area. Improved efficiency of farm operations and improved farm income due to the project will provide incentives for full utilization of farm land.

The project will reduce the amount and area of ponded floodwater which will reduce potential areas for breeding of mosquitoes. The floodwater retarding structures, diversions, and channels will be designed and constructed to drain floodwater without leaving shallow and stagnant pools. Site 19 will be designed and constructed with the shoreline falling abruptly to two or three feet, eliminating shallow water.

Land rights for the installation of the structural measures will require about 7,645 acres of agricultural land, of which 7,445 acres is rangeland and 200 acres is irrigated cropland. This change in use will significantly restrict agricultural production on the 7,645 acres. In addition, about 2,400 acres of rangeland will periodically be flooded in detention pool areas of the floodwater retarding structures and along floodwater diversions. This temporary flooding will interrupt agricultural use and incidental wildlife use of these areas for limited periods of time.

On-site field investigations of the surface and subsurface formations indicate that no significant mineral resources will be affected by installation of the project.

Five P.L. 566 projects have been approved for installation in the Upper Pecos Subarea which comprises San Miguel, Guadalupe, De Baca, Chaves,

and Eddy Counties. Two additional watersheds in the region or area have work plans completed. The watersheds approved and planned are independent of each other, not interrelated, and are geographically widely separated with the exception of the Cottonwood-Walnut Creek and Eagle-Tumbleweed Draw Watersheds. The total regional impact of the seven projects is difficult to assess since most of the benefits and adverse effects are localized in the watersheds and immediate trade areas.

PROJECT BENEFITS

Benefits from land treatment measures will be primarily on-site conservation benefits that will come from more efficient management of land and water. These measures will not significantly reduce flooding and were therefore not evaluated.

The structural measures included in the plan will reduce the estimated average annual flood damage in the watershed from $306,400 to $26,800, providing benefits of $279,600. These average annual benefits consist of $254,000 in the reduction of direct flood damage and $25,600 in the reduction of indirect flood damage (Table 5).

Other project benefits of $187,300 include $162,300 of direct average annual flood damage reduction benefits to urban property and $25,000 of indirect average annual flood damage reduction benefits in Damage Areas 1 and 4 in Artesia in the Eagle-Tumbleweed Draw Watershed (Table 5). However, the benefits accrue to structural measures in the Cottonwood-Walnut Watershed because Damage Areas 1 and 4 are a common overlapping damage area (Table 5).

The estimated average annual recreation benefits are about $98,100, based on anticipated use of the facilities and recreation reservoir. The estimated total annual recreation visits are 63,970. From this total, fishing, boating, camping, and picnicking account for 63,500 visits, valued at $1.50 per visit. This amounts to $95,250. The remaining 470 visits for hunting are valued at $6.00 per visit, or $2,820.

Redevelopment benefits from increased employment of local labor in the installation and operation of the project will amount to an estimated $148,700 on an average annual basis. This will be about 25 man-years of employment over the installation period and the first 25 years of operation and maintenance.

Local average annual secondary benefits are estimated to be $57,700. These are benefits induced by and stemming from the installation of

project measures. From a national viewpoint, they were not considered pertinent to the economic evaluation. At the local level they are significant but were not used for project justification.

COMPARISON OF BENEFITS AND COSTS

The average annual cost of the structural measures is $658,100. This includes $518,900 as the amortized installation cost and $80,400 for the replacement, operation, and maintenance of structural measures and basic facilities, plus $58,800 as the amortized cost of project administration (Table 4).

Total average annual benefits, including redevelopment and secondary benefits, are estimated to be $767,900. This results in an overall benefit cost ratio of 1.2:1 (Table 6).

The installation of structural measures included in the plan will produce estimated average annual benefits exclusive of secondary benefits of $710,200. The ratio of these benefits to the cost of the structural measures is 1.1:1.

PROJECT INSTALLATION

Land treatment measures will be established by farmers and ranchers over an eight-year period from the time of work plan development to the end of the project installation period. Approximately 12.5 percent of the conservation measures to be applied will be applied each year.

The Soil Conservation Service will help in the planning and application of these measures by providing technical assistance through the three Natural Resource Conservation Districts under the going programs and through Public Law 566 funds for technical assistance. The Bureau of Land Management concurs with the provisions of this plan.

The Bureau of Land Management will install the measures proposed on Type I federal land during the project installation period and provide their own technical assistance. Proper grazing use on federal land on the upland portions of the watershed will be continued by lessees with assistance from the Bureau of Land Management.

Structural measures will be installed during an eight-year period. Construction of these measures will start when the project is approved; all necessary land, easements, and rights-of-way have been obtained; operation and maintenance agreements signed; and federal funds are available.

A construction schedule will be agreed upon by the cooperating parties. It will be adjusted on the basis of any significant changes in the plan found necessary in the light of appropriations and progress actually made.

Salvage of archeological and historical material identified at or near floodwater retarding structure sites 7, 8, 13B and 15, Site 19, and floodwater diversions 2, 6, 7, and 8 will be done prior to construction. This work will be done by archeologists with the National Park Service, U. S. Department of the Interior.

The various features of cooperation between the Cottonwood-Walnut Creek District and the Service will be covered in appropriate memoranda of understanding and working agreements.

The Cottonwood-Walnut Creek Watershed District will be responsible for installing all structural measures except the basic facilities. The District has the powers of eminent domain and is willing to exercise these powers. It will acquire and bear all costs for land rights purchased in fee title and construction easements for the construction of all structures except Site 19. The Cottonwood-Walnut Creek Watershed District will make arrangements and be responsible for necessary land appraisals and legal surveys needed for securing land rights. The New Mexico State Park and Recreation Commission has purchased the land and water rights for Site 19 and the basic recreation facilities. The New Mexico Department of Game and Fish will establish and maintain a fishery at Site 19.

The Watershed District will receive State Engineer approval of plans, specifications, and permits to construct impoundment and floodwater retarding structures and otherwise comply with applicable state laws before issuing invitations to bid. The Watershed District will also let and service the contracts for the construction of the structural measures. At a later date, the sponsors may request the Soil Conservation Service to administer the contracts.

The Cottonwood-Walnut Creek Watershed District will develop and maintain a financial management system which will provide for:

(1) accurate and complete disclosure of financial transactions for each undertaking.

(2) records which identify the source and application of funds.

(3) effective control and accountability of funds.

(4) a comparison of actual funds for each undertaking with budgeted amounts.

(5) procedures to minimize time between transfer of funds and disbursement.

(6) procedures to determine allowability and allocability of funds.

(7) audits to determine the fiscal integrity of financial transactions and compliance with laws, regulations, and administrative requirements.

(8) a systematic method to assure timely resolution of audit findings.

(9) retaining financial records for a period of at least three years after the completion of the project.

(10) making financial records available for review by the federal government or its representative.

The New Mexico State Park and Recreation Commission will secure and contract for the engineering and architectural services for the design and installation of the basic facilities.

The Soil Conservation Service will provide technical assistance in preparation of the plans and specifications, supervision of construction, preparation of contract payment estimates, final inspection, certification of completion, and other related work. Site 19 is in series with and downstream from Site 5, Site 6, Site 7, Site 8, Site 14, Site 15, and Floodwater Diversion 7, and it will not be constructed until these measures are installed. Channel work on Cottonwood Creek will be done after the floodwater retarding structures and Site 19 are completed.

Site 1 and Site 4 drain through Site 3 and will not be installed until after Site 3 is installed. Floodwater Diversion 8 drains into Site 1 and will be constructed after the installation of Site 1.

FINANCING PROJECT INSTALLATION

Costs of applying necessary land treatment measures on private, state, and Type IV federal land will be borne by cooperators of the Central Valley, Penasco, and Hagerman-Dexter Natural Resource Conservation Districts. These cooperators will receive cost-sharing assistance, as applicable, through the Great Plains Conservation Program, the Rural Environmental Conservation Program, and technical assistance from the Soil Conservation Service. Additional assistance will be made available through P.L. 566 funds to accelerate installation of land treatment measures. Costs of installation of necessary land treatment measures of Type I federal land will be borne by the Bureau of Land Management.

The Cottonwood-Walnut Creek Watershed District is responsible for land rights and easements costs for the structural works of improvement, except for Site 19 and basic recreation facilities. The New Mexico State Park and Recreation Commission has acquired the land for the dam and reservoir and basic facilities at Site 19. The New Mexico Department of Game and Fish will acquire the water rights for the recreation pool and fishery at Site 19 from the State Park and Recreation Commission. The purchase of the water rights by the New Mexico Department of Game and Fish is contingent upon the availability and approval of federal matching funds, either Dingell-Johnson or Land and Water Conservation Funds, and upon approval of the State Game Commission and the State Board of Finance.

At the time a contract is awarded for the construction of the dam and reservoir at Site 19, the New Mexico State Game Commission will negotiate with the New Mexico State Park and Recreation Commission for the water rights in an amount that does not exceed $300,000, federal matching funds included. The New Mexico State Game and Fish will stock the reservoir at Site 19 with fish and assume this cost. The City of Artesia, through a supplemental agreement with the Watershed District, will assume the local obligation for Floodwater Diversion 8.

The Watershed District has reached agreements with utility companies in the area to relocate utilities where necessary at cost. They also have reached agreements with county and state highway departments to obtain easements free or at reduced costs. The New Mexico State Park and Recreation Commission and the Cottonwood-Walnut Watershed District will request construction funds from the New Mexico State Legislature for the local share of costs for Site 19, the basic facilities, and the architectural and engineering contract costs. The Cottonwood-Walnut Watershed District has the rights of eminent domain and taxation as a legal sub-division of the state and has adequate financing to meet local responsibilities with the assistance listed above.

Federal financial assistance in carrying out the project will be made available to the local organizations when the necessary land rights are obtained, when the local organizations have their share of construction costs, and when federal funds are available. Federal funds are contingent on appropriations made under Public Law 566.

The Soil Conservation Service will provide construction funds for the floodwater retarding structures, floodwater diversions, channel work, and the allocated flood prevention construction cost of the multipurpose structure, Site 19. The Soil Conservation Service will also bear 50 percent of the construction cost of Site 19 that is allocated to the recreational development and 50 percent of the construction cost of the basic recreation facilities. The Soil Conservation Service will cost-share up to 50 percent on the land rights cost of Site 19 allocated to recreation and 50 percent of the land rights cost for the basic facilities that have been acquired by New Mexico State Park and Recreation Commission.

The cost of archeological investigation and salvage will be from sources other than P.L. 566 funds. The National Park Service, U.S. Department of the Interior, will be responsible for this cost.

PROVISIONS FOR OPERATION AND MAINTENANCE

Land treatment measures on private, state-owned, and Bureau of Land Management Type IV federal land will be maintained by the landowner or operator on their land where these measures are applied under agreement with the Central Valley, the Penasco, or the Hagerman-Dexter Natural

Resource Conservation Districts. The Bureau of Land Management and lessees will maintain land treatment measures installed on Type I federal land administered by the Bureau.

Representatives of the sponsoring local organizations and the Soil Conservation Service will make a joint inspection of the structural measures annually after each major flood for three years following installation of each structure. The inspection(s) will be made to determine the need for maintenance and repair, and if required, when it will be accomplished. The Service will participate in annual inspections as often as it elects to do so after the third year. Inspection reports will be made by the sponsors with assistance from the Service, as required, and copies of reports will be furnished to the State Engineer.

The operation and maintenance of all structural measures except the basic facilities and recreation reservoir will be the responsibility of the Cottonwood-Walnut Creek Watershed District. The average annual operation and maintenance cost of the floodwater retarding structures, channels, the dam at Site 19, and diversions is estimated to be $46,200. The Watershed District will acquire the necessary funds for the operation and maintenance by assessing the benefited landowners.

Operation, maintenance, and replacement of basic recreational facilities will be the responsibility of the New Mexico State Park and Recreation Commission. The facilities will be operated and open to the public year-long. There will be provisions for free access and parking for hunters and fishermen using the recreation pool (Site 19).

Estimated average annual operation, maintenance, and replacement cost of basic recreational facilities and the recreation reservoir amount to $34,200. This includes the estimated average annual cost of $4,800 for replacement of basic facilities, $14,900 for custodial, policing, sanitation, safety, and other operational services of the recreational facilities, $7,800 for pumping water for the recreation reservoir and basic facilities, and $6,700 for the fishery. The basic recreational facilities and recreation area will be policed and maintained in a manner so as to insure the safety and health of the public users. The New Mexico Department of Game and Fish and the New Mexico State Park and Recreation Commission, by virtue of existing statutes, will have authority to regulate uses of the lake in the interests of public safety and wildlife and to exclude speedboating and water skiing. Boating will be limited to self-propelled boats, sailboats, and electric-powered trolling boats.

The New Mexico Department of Game and Fish will be responsible for the establishment and continuing management of the fishery. Estimated average annual cost of stocking and maintaining the fishery is $6,700.

The New Mexico State Park and Recreation Commission will operate and maintain the wells and pumps to provide water for the recreation pool and basic facilities.

Releases of water from multi-purpose Site 19 will be required to satisfy downstream water rights. To determine the time and rate of such releases will require the establishment and operation of inflow and outflow continuous measuring devices constructed and maintained in a manner suitable to the State Engineer and at the expense of the sponsors. The Cottonwood-Walnut Creek Watershed District will be responsible for the maintenance of tree and shrub plantings made as mitigation or enhancement measures.

The Cottonwood-Walnut Creek Watershed District and the Soil Conservation Service will enter into a specific operation and maintenance agreement prior to issuance of invitation to bid on construction. The estimated average annual operation, maintenance, and replacement cost for the project is $80,400. The operation and maintenance of structural measures will be carried out in a manner to comply with requirements of state and local health agencies including measures to control mosquito breeding areas. An operation and maintenance plan will be prepared for each structural measure.

Approximately eight years will be required for initial filling of the lake from the water rights acquired by the New Mexico Park and Recreation Commission. These water rights include 296 acres of ground water rights from three artesian wells, 225.3 acres of surface water rights from three diversions located upstream from Site 19 on Cottonwood Creek, and 64.7 acres of land having water rights from surface and/or artesian ground water sources. The water rights will be used to fill and maintain the recreation pool and to irrigate 14 acres of park developed as part of the basic facilities.

Pumpage from the artesian wells may not exceed the depletion rights of the water rights acreage transferred. This depletion right is estimated at 2.1 acre-feet per acre. All surface water inflow to the structure, exceeding surface water rights transferred, will be passed through the dam. There is also the possibility that some prior surface water rights may have to be satisfied before transferred surface water rights can be fully exercised.

Pesticides or insecticides which may be used in the operation and maintenance of project measures will be at Site 19. When needed, insecticides will be used on diseased landscape plants and to control houseflies at comfort stations and chemical toilets. The New Mexico State Park and Recreation, one of the project sponsors, will operate and maintain the recreation facilities and will apply insecticides or pesticides in conformity with existing regulations.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Cottonwood-Walnut Creek Watershed, New Mexico

Installation Cost Item	Unit	Number: Federal Land	Number: Non-Fed Land	Number: Total	Estimated Cost (Dollars) 1/: PL-566 Funds: Federal Land SCS 3/	PL-566 Funds: Non-Fed Land SCS 3/	PL-566 Funds: Total	Other Funds: Federal Land SCS 3/	Other Funds: Federal Land BLM 3/	Other Funds: Non-Fed. Land SCS 3/	Other Funds: Total	Total
LAND TREATMENT												
Land Areas 2/												
Cropland	Acres	-	20,000	20,000	-	-	-	-	-	1,979,500	1,979,500	1,979,500
Rangeland	Acres	39,900	100,100	140,000	-	-	-	32,500	8,100	99,400	140,000	140,000
Technical Assistance	-	-	-	-	-	82,300	82,300	7,500	-	45,200	52,700	135,000
TOTAL LAND TREATMENT	xxxxx	39,900	120,100	160,000	-	82,300	82,300	40,000	8,100	2,124,100	2,172,200	2,254,500
STRUCTURAL MEASURES												
Construction												
Floodwater Retarding Struct.	No.	2	9	11	1,213,200	3,016,600	4,229,800	-	-	-	-	4,229,800
Multi-Purpose Struct.	No.	-	1	1	-	1,176,400	1,176,400	-	-	243,500	243,500	1,419,900
Channel Work 4/												
(N)	Mi.	-	4.89	4.89	-	784,400	784,400	-	-	-	-	784,400
(O)	Mi.	-	4.77	4.77	-	361,000	361,000	-	-	-	-	361,000
Floodwater Diversions	Ft.	5,040	68,360	73,400	42,600	507,200	549,800	-	-	-	-	549,800
Basic Recreation Facilities	-	-	-	-	-	116,100	116,100	-	-	116,100	116,100	232,200
Subtotal - Construction		-	-	-	1,255,800	5,961,700	7,217,500	-	-	359,600	359,600	7,577,100
Engineering Services	-	-	-	-	75,800	415,700	491,500	-	-	10,500	10,500	502,000
Project Administration												
Construction Inspection					82,800	529,500	612,300	-	-	-	-	612,300
Other					61,300	315,100	376,400	-	-	9,500	9,500	385,900
					-	-	-	-	-			
Subtotal - Administration					144,100	844,600	988,700	-	-	9,500	9,500	998,200
Other Costs												
Land Rights					-	13,300	13,300	-	-	309,100	309,100	322,400
Water Rights					-	-	-	-	-	380,900	380,900	380,900
Archeological Salvage										20,000	20,000	20,000
Subtotal - Other						13,300	13,300	-	-	710,000	710,000	723,300
TOTAL STRUCTURAL MEASURES					1,475,700	7,235,300	8,711,000	-	-	1,089,600	1,089,600	9,800,600
TOTAL PROJECT					1,475,700	7,317,600	8,793,300	40,000	8,100	3,213,700	3,261,800	12,055,100

1/ Price base: 1975.

2/ Includes only areas estimated to be adequately treated during the project installation period. Treatment will be accelerated throughout the watershed and dollar amounts apply to total land areas and not just to adequately treated areas.

3/ Federal agency responsible for assisting in installation of works of improvement.

4/ Type of channel before project:
(N) - An unmodified, well-defined, natural channel or stream.
(O) - None or practically no defined channel.

June 1975

TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT
(at time of work plan preparation)

Cottonwood-Walnut Creek Watershed, New Mexico

Measures	Unit	Applied to Date	Total Cost (Dollars) 1/
LAND TREATMENT			
Conservation Cropping System	Ac.	19,238	--
Irrigation Water Management	Ac.	16,000	--
Irrigation Ditch Lining	Ft.	510,000	1,198,500
Irrigation Pipeline	Ft.	240,000	864,000
Irrigation Canals	Ft.	40,000	80,000
Irrigation Reservoir	No.	140	210,000
Land Leveling	Ac.	9,700	970,000
Deferred Grazing	Ac.	38,000	17,000
Fencing	Mi.	256	405,000
Diversions	Ft.	20,000	5,600
Livestock Pipeline	Ft.	70,000	17,000
Livestock Wells	No.	70	350,000
Pit Tank (Livestock)	No.	70	84,000
Proper Grazing Use	Ac.	66,200	66,200
Tank or Trough	No.	200	186,400
Structures for Erosion Control	No.	1,000	100,000
TOTAL	--	--	4,553,700

1/ Price base 1975

June 1975

TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION
(Dollars) 1/

Cottonwood-Walnut Creek Watershed, New Mexico

	Installation Cost - P.L.-566 Funds				Installation Cost - Other Funds						
	Construction	Engineering	Land Rights	Total P.L.-566	Construction	Engineering	Land Rights	Water Rights	Archeological Salvage	Total Other Costs	Total Installation Cost
Floodwater Retarding Structures:											
Site No. 1	192,400	14,900	-	207,300	-	-	19,400 3/	-	-	19,400	226,700
3	312,800	22,800	-	335,600	-	-	7,100 4/	-	-	7,100	342,700
4	250,000	19,500	-	269,500	-	-	2,400	-	-	2,400	271,900
5	274,700	21,300	-	296,000	-	-	6,000 5/	-	-	6,000	302,000
6	1,100,800	62,500	-	1,163,300	-	-	3,900 6/	-	-	3,900	1,167,200
7	112,400	10,400	-	122,800	-	-	600	-	1,000	1,600	124,400
8	1,079,300	61,700	-	1,141,000	-	-	18,000 7/	-	2,500	20,500	1,161,500
13B	91,100	7,700	-	98,800	-	-	18,600	-	4,000	22,600	121,400
14	146,600	13,200	-	159,800	-	-	20,800 8/	-	-	20,800	180,600
15	168,200	13,400	-	181,600	-	-	3,800	-	4,000	7,800	189,400
17A	501,500	38,200	-	539,700	-	-	36,800 9/	-	-	36,800	576,500
Multi-Purpose Structure:											
Site No. 19	1,131,300	78,700	8,700	1,218,700	180,400	-	9,300 10/	380,900	3,600	574,200	1,792,900
Pool Blanketing	9,000	1,100	-	10,100	9,000	-	-	-	-	9,000	19,100
Shoreline Shaping	36,100	4,300	-	40,400	36,100	-	-	-	-	36,100	76,500
Streamflow Measuring Devices	-	-	-	-	8,000	-	-	-	-	8,000	8,000
Stocking Reservoir with Fish	-	- 2/	-	-	10,000	-	-	-	-	10,000	10,000
Basic Recreation Facilities	116,100	10,500	4,600	131,200	116,100	10,500	5,100 10/			131,700	262,900
Floodwater Diversions:											
FD-1	144,000	9,500	-	153,500	-	-	6,100 11/	-	-	6,100	159,600
FD-2	35,600	2,200	-	37,800	-	-	1,900 12/	-	500	2,400	40,200
FD-6	145,400	9,600	-	155,000	-	-	20,500 13/		3,400	23,900	178,900
FD-7	115,000	7,100	-	122,100	-	-	15,400 14/	-	500	15,900	138,000
FD-8	109,800	7,900	-	117,700	-	-	34,200 15/	-	500	34,700	152,400
Channel Work:											
300	314,700	22,700	-	337,400	-	-	44,900 16/	-	-	44,900	382,300
500	46,300	3,400	-	49,700	-	-	6,700 17/	-	-	6,700	56,400
Cottonwood	784,400	48,900	-	833,300	-	-	27,600 18/	-	-	27,600	860,900
Subtotal	7,217,500	491,500	13,300	7,722,300	359,600	10,500	309,100	380,900	20,000	1,080,100	8,802,400
Project Administration	-	-	-	988,700	-	-	-	-	-	9,500	998,200
GRAND TOTAL	7,217,500	491,500	13,300	8,711,000	359,600	10,500	309,100	380,900	20,000	1,089,600	9,800,600

1/ Price Base 1975.
2/ Engineering contract costs to be borne--$10,500 by PL-566 funds and $10,500 by other funds.
3/ Includes $200 for reconstructing fences, $2,500 for modifying utilities, $500 for surveys.
4/ Includes $200 for reconstructing fences.
5/ Includes $200 for reconstructing fences.
6/ Includes $300 for reconstructing fences, $1,600 for modifying utilities, $500 for surveys.
7/ Includes $11,500 for the relocation of utilities (gas & electric), $3000 for relocation of road, & $500 for reconstructing fences.
8/ Includes $5,200 for relocating pipeline, $3,500 for relocating road, and $200 for reconstructing fences.
9/ Includes $1,400 for modifying powerline, $4,200 for relocating road, $3,000 for relocating house & well, & $500 for reconstructing fences.
10/ Includes $500 for survey, legal fees and other costs.
11/ Includes $200 for reconstructing fences.
12/ Includes $100 for reconstructing fences.
13/ Includes $200 for modifying pipeline, $9,700 for road crossing, $1,600 for gated outlets, and $300 for reconstructing fences.
14/ Includes $4,500 for road crossing, $600 for gated outlets, and $500 for reconstructing fences.
15/ Includes $24,100 for road crossings, $200 for modifying pipeline, and $400 for reconstructing fences.
16/ Includes $18,000 for road crossings, $1,000 for modifying utilities, & $1,000 for reconstructing fences.
17/ Includes $4,400 for two crossings and $100 for reconstructing fences, and $200 for surveys.
18/ Includes $4,000 for road crossings, $2,000 for modifying utilities, $5,000 for reconstructing fences, and $2,000 for surveys.

TABLE 2A - COST ALLOCATION AND COST-SHARING SUMMARY
(Dollars) 1/

Cottonwood-Walnut Creek Watershed, New Mexico

	COST ALLOCATION			COST-SHARING					
	Purpose			PL-566 Funds			Other Funds		
	Flood Prevention	Recreation	Total	Flood Prevention	Recreation	Total	Flood Prevention	Recreation	Total
Floodwater Retarding Structures Sites 1, 3, 4, 5, 6, 7, 8, 13B, 14, 15 & 17A	4,664,300	-	4,664,300	4,515,400	-	4,515,400	148,900	-	148,900
Floodwater Diversions 1, 2, 6, 7, & 8	669,100	-	669,100	586,100	-	586,100	83,000	-	83,000
Channels: 300, 500, & Cottonwood	1,299,600	-	1,299,600	1,220,400	-	1,220,400	79,200	-	79,200
Multipurpose Structure (Site 19)	1,010,000	401,200	1,412,000	1,008,100	210,600	1,218,700	2,700	190,600	193,300
Water Rights	-	380,900	380,900	-	-	-	-	380,900	380,900
Pool Blanketing (Site 19)	-	19,100	19,100	-	10,100	10,100	-	9,000	9,000
Shoreline Shaping (Site 19)	-	76,500	76,500	-	40,400	40,400	-	36,100	36,100
Streamflow Measuring Devices	-	8,000	8,000	-	-	-	-	8,000	8,000
Stocking Reservoir with Fish	-	10,000	10,000	-	-	-	-	10,000	10,000
Basic Recreation Facilities	-	262,900	262,900	-	131,200	131,200	-	131,700	131,700
TOTAL	7,643,800	1,158,600	8,802,400	7,330,000	392,300	7,722,300	313,800	766,300	1,080,100

1/ Price Base 1975

June 1975

TABLE 2B - RECREATION FACILITIES
ESTIMATED CONSTRUCTION COSTS
COTTONWOOD-WALNUT CREEK WATERSHED

ITEM	UNIT	NUMBER 1/	EST. UNIT COST 2/	TOTAL COST
Picnic and Camp Units - Prefab Metal, shade shelters, gravel pad and parking space, concrete table with benches, metal grill, trash can	each	60	$1,000	$60,000
Boating:				
Launch ramp-reinforced concrete 30 ft. x 100 ft.	each	1	6,500	6,500
Tie-up dock-6 ft. x 60 ft., floating w/gangplank access	each	1	2,000	2,000
Parking area-500 sq. ft./car and trailer gravel surface	spaces	50	100	5,000
Sanitary Facilities:				
Six unit comfort station, flush toilets & lavatories, septic tank and subsurface disposal system.	each	1	36,000	36,000
Chemical toilets	each	2	300	600
Water System:				
Well	each	1	3,000	3,000
Distribution lines	feet	7000	1.50	10,500
Drinking fountains w/taps	each	3	60	200
Sprinkler irrig. of facilities area	acre	7	1,000	7,000
Buried lines to irrigate trees	feet	2000	1.00	2,000
Landscaping:				
Revegetation of facilities areas	acre	7	80	600
Revegetation shoreline shaping areas	acre	18	60	1,100
Shade trees and shrubs	each	300	20	6,000
Access:				
Fencing	feet	9000	.65	5,800
Double lane road, gravel	feet	7000	5.00	35,000
Traffic control barriers	each	20	100	2,000
Signs	total			2,000
Entrance gate	each	1	300	300
Electric Service-Primary line on poles				
Secondary lines buried	feet	7000	1.00	7,000
Night lighting-on poles	each	5	180	900
TOTAL				193,500
Contingencies (20% x $193,500)				38,700
GRAND TOTAL				232,200

1/ All quantities estimated and subject to change at the time of detailed facilities planning.
2/ Price base 1975

June 1975

TABLE 2 - STRUCTURAL DATA

STRUCTURES WITH PLANNED STORAGE CAPACITY

Cottonwood-Walnut Creek Watershed, New Mexico

ITEM	UNITS	SITE 1	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 13B	SITE 14	SITE 15	SITE 17A	SITE 19	TOTAL
Class of Structure	XXX	c	c	a	a	c	a	a	a	a	a	b	c	---
Drainage Area	Sq. Mi.	8.93[1]	13.57[2]	10.71	10.25	42.03	6.39	59.65	24.06	4.54	4.62	68.15	28.40	281.80
Controlled	Sq. Mi.	---	---	---	---	---	---	---		---	---	---	127.98	---
Curve No. (1-day average AMC)	XXX	65	65	65	65	65	65	66	66	64	65	66	66	---
Tc	Hrs	2.60	2.10	3.50	3.10	3.75	2.05	7.62	3.50	1.95	0.63	9.05	3.75	---
Elevation Top of Dam	Ft.	3,472.1	3,439.9	3,513.2	3,577.0	3,636.4	3,624.0	3,682.0	3,487.2	3,603.4	3,618.8	3,530.1	3,482.3	---
Elevation Crest of Emergency Spillway	Ft.	3,469.0	3,436.0	3,510.3	3,571.6	3,613.8[5]	3,618.2	3,672.0	3,485.2	3,593.2	3,611.7	3,522.7	3,468.3	---
Elevation Crest High Stage Inlet	Ft.	3,455.8	3,425.7	3,499.8	3,562.7	3,600.6	3,606.8	3,643.2	3,479.2	3,591.5	3,604.5	3,505.4	3,459.0	---
Maximum Height of Dam	Ft.	21.3	23.9	20.9	22.0	56.9	28.0	60.0	12.3	17.8	19.3	50.1	47.9	---
Volume of Fill	Cu. Yds.	113,500	210,000	170,300	208,100	814,100	83,200	1,248,000	49,100	191,700	140,100	435,500	793,700	4,367,300
Storage Capacity	Ac. Ft.	1,900	2,043	1,310	1,103	3,420	826	13,488	2,613	494	554	5,477	4,150	37,378
Sediment Submerged 1st 50 Years	Ac. Ft.	---	---	---	---	---	---	---	---	---	---	---	270	270
Sediment Submerged 2nd 50 Years	Ac. Ft.	---	---	---	---	---	---	---	---	---	---	---	270	270
Sediment Aerated	Ac. Ft.	134	285	180	155	670	140	988	300	72	72	845	77	3,918
Beneficial Use Recreation	Ac. Ft.	---	---	---	---	---	---	---	---	---	---	---	1,143	1,143
Retarding	Ac. Ft.	1,766	1,758	1,130	948	2,750	686	12,500	2,313	422	482	4,632	2,390	31,777
Surface Area	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
Sediment Pool	Acres	Dry Dam	Dry Dam	Dry Dam	Dry Dam	Dry Dam	Dry Dam	Dry Dam	Dry Dam	Dry Dam	Dry Dam	Dry Dam	108	108
Beneficial Use (Recreation)	Acres	---	---	---	---	---	---	---	---	---	---	---	150	150
Retarding Pool	Acres	255	276	164	153	345	98	811	620	105	108	425	365	3,725
Principal Spillway Design[6]	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	---
Rainfall Volume (areal) (1-day)	In.	5.00	4.92	5.00	5.00	4.75	5.00	4.70	4.80	5.00	5.00	4.71	4.80	---
Rainfall Volume (areal) (10-day)	In.	8.00	7.94	8.00	8.00	7.90	8.00	7.76	7.80	8.00	8.00	7.74	7.84	---
Runoff Volume (10-day)	In.	3.02	2.79	2.86	2.50	1.98	2.68	1.94	2.56	2.56	2.91	2.11	2.16	---
Capacity of High Stage	c.f.s.	97	400	94	90	336	55	446	219	52	50	652	1,942 [7]	---
Frequency Operation - Emergency Spillway	% chance	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	---
Size of Conduit	Diam.In.	30	60	30	30	48	24	54	54	24	24	60	6' x 7' Box	---
Emergency Spillway Design[3]	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	---
Rainfall Volume (ESH) (Areal)	In.	9.50	9.50	4.00	4.00	3.17	4.00	5.60	3.72	4.00	4.00	6.00	7.73	---
Runoff Volume (ESH)	In.	5.14	5.14	1.03	1.03	4.03[5]	1.02	2.14	0.93	0.97	1.03	2.44	3.78	---
Type	XXX	earth	earth	earth	earth	concrete[5]	earth	earth	earth	earth	earth	rock	Ogee Sec.	---
Bottom Width	Ft.	1,400	1,400	800	1,000	100	600	1,100	1,400	500	400	700	400	---
Velocity of Flow (ve)	Ft./Sec.	1.0	No flow	No flow	No flow	10.0	No flow	No flow	No flow	No flow	No flow	6.2	9.9	---
Slope of Exit Channel	Ft./Ft.	.08	---	---	---	.33	---	---	---	---	---	2.3	1.25	---
Maximum Water Surface Elevation	Ft.	3,469.0	3,434.4	3,505.8	3,568.3	3,621.0	3,614.2	3,662.4	3,482.5	3,595.8	3,609.0	3,525.7	3,471.7	---
Freeboard Design	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	---
Rainfall Volume (FH) (Areal)	In.	25.20	25.20	9.90[3]	20.50[4]	22.17	20.50[4]	21.90[4]	6.32	20.50[4]	20.50[4]	11.53	20.50	---
Runoff Volume (FH)	In.	19.73	19.73	5.47	15.20	16.80	15.20	16.73	2.63	15.01	15.20	7.04	15.39	---
Maximum Water Surface Elevation	Ft.	3,472.1	3,439.9	3,513.2	3,577.0	3,636.4	3,624.0	3,682.0	3,486.2	3,603.4	3,618.8	3,530.1	3,482.3	---
Capacity Equivalents	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	---	---	---	---	---	---
Sediment Volume	In.	0.28	0.39	0.32	0.29	0.30	0.36	0.31	0.24	0.30	0.29	0.23	0.41	---
Retarding Volume	In.	3.96	4.29	2.02	1.73	1.28	1.87	3.93	1.80	1.74	1.96	1.27	1.58	---

1/ For E.S. routing use 6.67 sq. miles.)
2/ For E.S. routing use 5.85 sq. miles.) FD-1, FD-2 & FD-8 are designed with pre-positioned breach sections for runoff in excess of 1% 24-hr storm
3/ Emergency spillway design hydrographs for site 4 was developed using criteria midway between class "a" and "b".
4/ PMP used to provide additional freeboard.
5/ 1,400-foot auxiliary earth spillway at elevation 3629.8.
6/ Single stage inlet.
7/ This is greater than the Q_{100}.

June 1975

TABLE 3A - STRUCTURAL DATA

CHANNELS

Cottonwood-Walnut Creek Watershed, New Mexico

Channel	Reach From Station	Reach To Station	Drainage Area (Sq.Mi.)	Capacity (cfs)	Hydraulic Gradient (ft/ft)	Channel Dimensions Bottom (Ft.)	Depth (Ft.)	Side Slopes	"n" Value As-Aged	"n" Value As-Built	Velocities (ft./sec.) As-Aged 3/	Velocities (ft./sec.) As-Built 4/	Excavation (cu.yds)	Type of Work 5/	Before Project Type of Channel 6/	Before Project Flow Condition 7/
Cottonwood Creek	678+00	860+00	5.33	2460 1/	.00045	50	9.0	3:1	.030	.025	3.6	3.8		II	N	E
	860+50	880+00	5.33	2480 1/	.0006	50	8.2	3:1	.030	.025	4.0	4.2		II	N	E
	880+00	936+00	5.33	1500 2/	.0006	28	8.0	3:1	.030	.025	3.7	4.4	404,000	I	O	I
Channel 300	101+00	286+20	0	404 2/	.00025	45	3.8	3:1	.0275	.020	1.9	1.9	224,000	I	O	E
Channel 500	10+00	77+00	0	100 2/	.0025	10	2.0	2:1	.030	.025	3.4	3.8	25,000	II	O	E

1/ $Q_{1\%}$ - Principal spillway discharge + $Q_{1\%}$ from uncontrolled area.

2/ Q = $Q_{1\%}$ principal spillway discharge.

3/ Velocity used for capacity.

4/ Velocity used for stability analyses.

5/ I - Establishment of new channel including necessary stabilization measures.
II - Enlargement or realignment of existing channel or stream.

6/ N - An unmodified, well defined natural channel or stream.
O - None or practically no defined channel.

7/ I - Intermittent; continuous flow through some seasons of the year but little or no flow through other seasons.
E - Ephemeral; flows only during periods of surface runoff, otherwise dry.

June 1975

TABLE 3B - STRUCTURAL DATA

GRADE STABILIZATION STRUCTURES

Cottonwood-Walnut Creek Watershed, New Mexico

Site No. or Station	Drainage Area (Sq.Mi.)	Design Capacity Principal Spillway (c.f.s.)	Associated Frequency and Duration of Storm (% Chance & Hours)	6/ Drop (Ft)	Total 7/ Concrete (C.Y.)	Type of 8/ Structure
Channel 300						
4 ea.	17.8 1/	404	1%--10 Day	6	200	SD
3 ea.	"	"	" "	8	165	SD
2 ea.	"	"	" "	3	196	IO
1 ea.	"	"	" "	6	117	IO
Channel 500						
2 ea.	10.45 2/	100	1%--10 Day	8	80	SD
F.D.-6						
1 ea.	28.03 3/	1772 3/	1%--6 hour	14	155	CH
Cottonwood Channel						
1 ea.	163.95 4/	2460 5/	1%--10 day	18	260	CH
4 ea.	163.95	2460	" "	9	1160	SD
1 ea.	163.95	2460	" "	7.5	290	SD

1/ Local drainage does not add to peak; Site 3 controls 13.57 square miles.
2/ Local drainage does not add to peak; Site 5 controls 10.25 square miles.
3/ 24.06 sq. mi. controlled by Site 13B; - Drop Spillway Capacity is 1772 c.f.s. - Principal Spillway Capacity site 13B is 233 c.f.s.
4/ 156.38 sq. mi. controlled by Sites 5, 6, 7, 8, 14, 15 & 19.
5/ Combined P.S. discharge of Site 19 (1500 c.f.s.) plus side drainage.
6/ Figures shown are differences in channel bottoms. Structure floors are further depressed to satisfy tailwater requirements.
7/ Concrete computed on structures proportioned to pass the Q 1%.
8/ SD=Straight Drop Spillway; CH=Chute Spillway; and IO=Inlets on culverts.

June 1975

TABLE 3C - STRUCTURAL DATA

FLOODWATER DIVERSIONS

Cottonwood-Walnut Creek Watershed, New Mexico

Floodwater Diversion No.	Reach From Station	Reach To Station	Drainage Area Sq. Mi.	Planned Capacity cfs	Hydraulic Dimensions Bottom Ft.	Depth Ft.	Gradient Ft./Ft.	Velocity fps	Embankment Slope	Design Frequency %	Volume of Excavation Cu. Yds.
FWD 1 1/	51+00	102+00	0.26	154	12	3.2	.00075	2.29	3:1	1	105,081
	102+00	192+00 2/	7.30	2220	100	5.8	.0005	3.24	3:1	1	
FWD 2	100+00	120+00 3/	--	105	20	2.8	.0003	1.4	3:1	1	14,704
	102+00	160+00 3/	0.42	365	30	3.6	.00065	2.5	3:1	1	
FWD 6	93+00	160+50	1.47	780	20	6.4	.0006	3.14	3:1	1	
	160+50	200+50	3.28	1260	40	6.4	.0006	3.41	3:1	1	58,120
	200+50	263+00	3.97	1620	50	6.4	.0007	3.78	3:1	1	
FWD 7	5+00	30+00	--	53	0	3.6	0	0.56	3:1	1	
	30+00	110+00 3/	0.75	623	120	3.6	.00015	1.35	3:1		68,682
	110+00	209+00 3/	0.95	658	60	3.6	.0006	2.6	3:1	1	
FWD 8	137+00	151+00	0.54	221	20	3.2	.00075	2.43	3:1	1	
	151+00	185+00	1.23	519	20	5.0	.00075	3.0	3:1	1	
	185+00	254+00	2.26	1254	60	4.4	.00075	4.0	3:1	1	92,090
	254+00	270+00 3/									

1/ Principal spillway discharge = 97 c.f.s.
2/ Outlet section has a diverging bottom.
3/ Outlet section with diverging bottom and soil cement cap.

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TABLE 4 - ANNUAL COST

Cottonwood-Walnut Creek Watershed, New Mexico

(Dollars) 1/

Evaluation Unit	Amortization of Installation Cost 2/	Operation and Maintenance Cost 3/	Total
Cottonwood Creek	467,200	75,900	543,100
Walnut Creek	51,700	4,500	56,200
Project Administration	58,800	--	58,800
GRAND TOTAL	577,700	80,400	658,100

1/ Price Base: 1975.
2/ 100 years at 5-7/8 percent interest.
3/ Includes $19,700 for operation, maintenance, and replacement of basic recreational facilities and $14,500 for establishing and maintaining the recreation pool and fishery.

June 1975

TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Cottonwood-Walnut Creek Watershed, New Mexico

(Dollars) 1/

Item	Estimated Average Annual Damage 2/		Damage Reduction Benefit
	Without Project	With Project	
Floodwater-Agric.			
Crop and Pasture	237,200	21,100	216,100
Other Agricultural	38,000	2,800	35,200
Subtotal	275,200	23,900	251,300
Floodwater-Nonagric.			
Residential	200	-	200
Road and Bridge	2,400	400	2,000
Railroad	600	100	500
Subtotal	3,200	500	2,700
Indirect	28,000	2,400	25,600
Total in this Watershed	306,400	26,800	279,600
Benefits outside Project Area	-	-	187,300 3/
Total damage reduction benefits from measures in this watershed	-	-	466,900

1/ Price Base: Agr. Current Normalized; Non-agr. 1975 values.
2/ Damages will occur from floods of greater magnitude than the one-percent-chance or 100-year frequency flood but were not evaluated.
3/ Benefits from damage reduction in the Eagle-Tumbleweed Watershed but accruing to measures in the Cottonwood-Walnut Creek Watershed.

June 1975

TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Cottonwood-Walnut Creek Watershed, New Mexico

(Dollars)

Evaluation Unit	AVERAGE ANNUAL BENEFITS 1/					Average Annual Cost 3/	Benefit Cost Ratio
	Damage Reduction 2/	Recreation	Re-development	Secondary	Total		
Cottonwood Creek	391,100	98,100	134,600	50,600	674,400	543,100	1.2:1
Walnut Creek	72,300	-	14,100	7,100	93,500	56,200	1.7:1
Project Administration	-	-	-	-	-	58,800	-
GRAND TOTAL	463,400	98,100	148,700	57,700	767,900	658,100	1.2:1

1/ Price Base: Agr. Current normalized; Non-Agr. 1975. June 1975

2/ It is estimated that land treatment measures will provide a 5 percent reduction in sediment yield to the floodplain or about $3,500 average annual damage reduction benefits.

3/ From Table 4.

INVESTIGATIONS AND ANALYSES

ENGINEERING

Aerial photographs and United States Geological Survey topographic quadrangles were studied for possible approaches that would solve the flood problems in the watershed. After the source of damaging floods was identified, floodwater retarding structures, floodwater diversions, and channels were located to control floods from these draws. The structural measures were located by considering topography at the sites and the degree of control afforded by each individual structure.

Nineteen floodwater retarding structure sites with associated outlets and eight floodwater diversions were tentatively located and surveyed. Four of these proved to be inadequate; four alternate retarding structure sites were surveyed.

The following surveys were made to develop data for the detailed planning of the structural measures in this plan:

1. Differential level surveys to establish sea level elevations at each proposed structure site.

2. Plane table and alidade topographic surveys with a four-foot contour interval of all the reservoir sites.

3. Plane table and alidade topographic surveys of all the diversions.

4. Differential level surveys to establish the profile and prepare cross sections of all the channels and their floodplains.

Elevation-storage curves were made from the topographic maps of the reservoir sites for proportioning and flood routing.

The floodwater retarding structures were planned using the limiting criteria for proportioning earth dams and associated spillways as set forth in Engineering Memorandum SCS-27 (Rev.), March 19, 1965, as supplemented, and Technical Release No. 52. These criteria have been met in the design of the dams and emergency spillways.

All earth emergency spillways on sites with drainage areas greater than 10 square miles have divider dikes planned so that flowage bays are limited to 200 feet or less. Emergency spillway widths shown in Table 3 are actual flowage areas. Due to limited soils data, emergency spillway stability was established by assuming poorest soil conditions.

The diversions and open channels were planned and meet the criteria specified in Soil Conservation Service Technical Release 25.

FD-1, FD-2, and FD-8 are designed with a pre-positioned break section when the peak flow exceeds that produced by the one-percent-chance-of occurrence storm.

Site 1 was classified as a "c" structure. Several alternate structure layouts were evaluated. Various combinations of reinforced concrete chutes and auxiliary earth emergency spillways were evaluated.

A two-stage principal spillway to replace the chute and single-stage principal spillway was evaluated and it was obvious that it was more costly. A 1,400-foot wide earth emergency spillway in the left abutment proved to be the most economical combination and was the final selection.

Site 3 was classified as a "c" structure. Various concrete chute widths and structure layouts were evaluated. A 1,400-foot wide earth emergency spillway on the right abutment proved to be the most economical and was the final selection.

Site 4 was classified as an "a" structure. An 800-foot wide earth spillway in the left abutment was selected.

Floodwater Diversion 1 was evaluated for several alignments and chosen in lieu of Floodwater Retarding Structure 2. It serves as an outlet channel for Site 1 and diverts floodwater into Site 3 for retardation. The diversion is stable and outlets onto irrigated permanent pasture; therefore, the outlet is stable as planned.

Floodwater Diversion 2 was chosen as an outlet for Site 4. It diverts water into Site 3 drainage. The diversion is designed on a stable grade and the outlet is stabilized with a soil cement sill to assure spreading of the flow, resulting in non-erosive velocities at the outlet.

Floodwater Diversion 8 diverts floodwater into Site 1 drainage for retardation. Several bottom widths and alignments were evaluated; the final selecting being the most economical. The diversion is designed on a stable grade and the outlet will be protected against erosion by a soil cement sill to spread the flow to obtain a non-erosive velocity.

Several proposals were evaluated for Channel 300. A concrete-lined channel was optimized for cross-section and alignment. A vegetated earth channel was optimized. An unprotected earth channel was tried, but proved to be unfeasible. An earth channel with concrete drop structures was optimized. The least costly and most practical proposal proved to be the earth channel with 10 concrete drop structures. This was the final selection.

Sites 5, 6, 7, 8, 14, and 15 are above and in series with Site 19, and are designed with sufficient freeboard in the emergency spillway to pass the peak runoff produced by the probable maximum precipitation storm. Due to the large drainage area above Site 8, areal reduction was used for that area. Areal reduction and storm duration for the total area above Site 19 was used for routing through Sites 5, 7, 14, and 15 to determine emergency spillway freeboard for each structure.

Site 5 was classified as an "a" structure. Several earth emergency spillways were evaluated for both abutments with the selection being a 1,000-foot width; 500 feet in the right abutment, and 500 feet in the left abutment.

Site 6 was classified as a "c" structure. Various combinations of reinforced concrete chutes and auxiliary earth emergency spillways were evaluated. The final selection was a 100-foot wide concrete chute with a 1,400-foot auxiliary earth emergency spillway in the left abutment.

Site 7 was classified as an "a" structure. Various structure layouts and emergency spillways were evaluated. A 600-foot wide earth spillway in the right abutment was the final selection.

Site 8 was classified as an "a" structure. It is in series above Site 19 (class "c"). Several combinations of concrete chute widths and earth auxiliary emergency spillway widths were evaluated. An 1100-foot wide earth spillway in the left abutment was selected for Site 8. Floodwater retarding volume was increased to 12,500 acre-feet to decrease flow at Site 19.

Sites 9, 10, 11, and 12 were proportioned but eliminated when Site 8 proved to be the more economical.

Sites 14 and 15 were classified as "a" structures. Various structure layouts and earth emergency spillway widths were evaluated. The most economical combination for Site 14 is a 500-foot emergency spillway in the left abutment and for Site 15 a 400-foot emergency spillway in the left abutment.

Floodwater Diversions 3, 4, and 5 were evaluated. Diversions 3 and 4 were eliminated because of a land-use change which made them too costly. Diversion 5 was combined with Flood Diversion 6.

Multiple-purpose structure, Site 19, was classified as a "c" structure. Various structure layouts, chute widths, and crest elevations were evaluated. These findings were compared with their associated permanent pool areas and depths. An emergency spillway crest elevation at 3,468.3 with a 400-foot wide gravity section was selected. Various pool area excavation and shoreline fill quantities to increase the average depth of the permanent pool and eliminate shallow water were evaluated. It was determined that approximately 100 acre-feet of this excavation and fill is desirable. There will be selective excavation so as not to expose porous material in the permanent pool area.

Channel 500 was planned to transport the principal spillway flows of Site 5 to Cottonwood Channel. A concrete-lined channel design was optimized. An unprotected earth channel was studied but proved to be unfeasible. An earth channel with drop structures was optimized. The least costly and most practical proposal proved to be the earth channel with two 8-foot concrete drop structures and was the final selection.

Cottonwood Channel

The existing channel banks and bottom from Site 19 to Section 647+00 (Highway 285) are in cemented conglomerate materials. Box culverts convey the flow under the highway; therefore, this reach of the channel would be stable under future with-project conditions.

An overfall of about 18 feet exists in erosive soil materials at about Station 678+00. Soil materials from Station 678+00 to 706+00 were shown to be erosive; Station 706+00 to 800+00 (cemented materials) stable at existing grade and cross-section; Station 800+00 to 860+00 (Alternate U.S. Highway 285) erosive with existing grade. The existing channel capacity from 860+00 to the Pecos River was too small to convey the flow under future with-project conditions.

Conclusions were no channel work from Site 19 to Station 678+00; install a 20-foot concrete chute at Station 678+00; install class "c" drops at Stations 706+00, 740+00, 760+00, 800+00, and 840+00 with necessary channel shaping and diking to install the drops. From Station 880+00 to the Pecos River, a direct route was determined to be the most logical and economical channel. Cottonwood Channel, with the above work, will be stable under future with-project conditions.

Floodwater Diversion 7 diverts floodwater and the principal spillway discharges of Sites 14 and 15 directly into Cottonwood Creek. Several alignments and cross-sections were evaluated with the final selection being the one that was the most economical.

Site 13B was classified as an "a" structure. A 1,400-foot earth emergency spillway was located in a natural saddle in the center of the dam.

Sites 16 and 16B were proportioned but proved to be too costly and could not be justified. Site 17A was classified as a "b" structure. An emergency spillway, 700 feet wide, was located in rock on the left embankment with soil cement in the cut ends to provide erosion protection above the rock line. Site 17 was proportioned; however, Site 17A was more economical.

Floodwater Diversion 6 serves as an outlet channel for Site 13B and diverts floodwater directly into Walnut Creek. Several alignments were evaluated with the final selection being the least costly for the desired benefits. A concrete chute spillway, with a drop of 14 feet, will be installed where the diversion converges with Walnut Creek.

Walnut Channel

Existing channel capacity was analyzed for future with-project conditions. The existing system was found to have sufficient capacity for the 10-year frequency future condition flow except in the vicinity of Station 580+00

where there would be overbank flooding. This was true for the 100-year frequency flow as well. No benefited area was claimed.

The next field of study was oriented toward channel regime and channel stability under future with-project-flow conditions. The existing channel was constructed in the early 1900's and excavated in highly cemented soils. The nature and extent of cementation was verified during investigations by collection of six undisturbed samples and unconfined compressive strength tests made. Utilizing this test data, the stability was evaluated based on the tractive power concept set forth in Technical Release 25 (SCS). This evaluation showed the material to be non-erosive with velocities (bank full capacity) associated with the 100-year frequency storm under future with-project-flow conditions.

The effects of detention in the planned structures on sediment transport were investigated. The results were as follows: (1) Low gross erosion, about two-fifths of an acre-foot per square mile, without land treatment, and with only a slight reduction with proposed land treatment; (2) relatively low delivery rates; and (3) little change in constructed channel cross-section and no degradation of channel bottom. These results led to the decision that changed sediment transport would be insignificant. Peak discharges under future with-project conditions will be greatly reduced with no undue extension of flow duration at bank-full capacity. Knowledge of the above and the fact that the objectives of the sponsoring local organization would be met led to the decision that channel work was not needed on Walnut Creek. The existing Walnut Creek channel is stable and has sufficient capacity to meet the objectives and will convey the principal spillway flows from Sites 13B and 17A to the Pecos River.

Basis for Planning Estimates

Earth quantities were based on centerline heights of embankments and depths of excavation using differential leveling or from topographic maps, to obtain centerline profiles. These preliminary designs, principal spillway and emergency spillway layouts, and sizes are not final and do not preclude possibly installing multiple-stage principal spillways, if practical, in final design.

Cost estimates for these planned structural measures are based on the quantity estimates from preliminary designs and the current unit prices for similar work in this locality. Where local cost information was not available, costs for similar construction in other areas were used after being adjusted to the local conditions. Contingencies of 12 percent to 20 percent were added to the engineer's cost estimates for the possibility of unforeseen costs.

HYDROLOGY AND HYDROLOGIC INVESTIGATIONS

General

Hydrology studies were primarily concerned with:

1. Determination of the present and future depth area inundated-frequency relationships for evaluation.

2. Determination of floodwater storage requirements.

3. Computation and routing of design hydrographs.

4. Computation of water budget for the recreation pool of the multi-purpose reservoir.

Climatological

Eight recording and nonrecording precipitation stations, and three evaporation stations are located in the vicinity of the watershed. Four recording precipitation stations: Artesia, Maljamar, Roswell, and Carlsbad have relatively long records. Duration-frequency-point rainfall data was worked up in detail for these stations and compared to point rainfall values from Weather Bureau Technical Papers 40 and 49. Point rainfall values from the Weather Bureau papers were used for consistency.

Class A land pan evaporation data was available from Bitter Lakes Wildlife Refuge Station, Lake Avalon Station, and Lake McMillan Station. Bitter Lakes and Lake Avalon Stations each had 15 years of records. Lake McMillan had 10 years of records.

Streamflow

One recording streamflow gage is located on Cottonwood Creek. This gage has a lengthy record, but the station is primarily used as a low-water gage. Due to channel capacity and location of this gage, its use in determining peaks or volumes could be extremely erroneous.

Hydrologic Conditions

A standard soil survey of the watershed area was made and basic soils data for hydrologic classification was obtained. The type and condition of cover on the watershed area was determined by field reconnaissance.

Surveys

Topographic surveys made of reservoir sites were used to determine structure capacity. Channel cross sections and profiles were taken for flood routing, evaluation, and design of improved channels.

A base map of the watershed was prepared from United States Geological Survey quadrangle sheets. Sub-watershed boundaries were outlined and soil cover complex data was tabulated on the map.

Historical Flood Events

Major floods on all or part of the watershed have occurred in 1915, 1921, 1924, 1932, 1937, 1941, 1946, 1954, 1960, 1965, 1965, 1966, and 1967. Data from the Soil Conservation Service flood reports, newspaper accounts, and United States Geological survey reports of floods within the watershed were used. Additional data on extent of flooding was obtained by interviews with local residents. Flood frequencies were determined for the more recent floods so that depth-area-inundated data gathered on the floods could be used as a guide in economic evaluation.

Evaluation Hydrology

Evaluation was performed for (1) future conditions without project and for (2) future conditions with structural measures installed.

A systematic evaluation series of volume and peak ratio of runoff was developed for each evaluation unit. For the Cottonwood and Walnut evaluation units, the development of evaluation hydrographs and flood routings through channel reaches was facilitated by the use of an electronic computer. The project formulation program-hydrology, the use of which is outlined in Soil Conservation Service Technical Release No. 20, was used. By use of the program, several types of storms could be analyzed so the one that best fits historic flood patterns could be selected. Many alternate combinations of structural measures could be evaluated using the program.

The procedure was to plot on a base map the width of flooding for three storm frequencies at the location of a surveyed cross section of the channels through the damage area. The limits of flooding were connected to produce an area flooded which was measured as the area inundated for a given storm frequency. Areas remaining flooded with combinations of works of improvement in place were found by routing flood flows through structures and channel reaches by use of the computer program and plotting as above.

Lines showing limits of flooding for recent large historical storms were plotted on the map and used as a guide in plotting the area flooded by frequency. The evaluation of the "tributaries" of Cottonwood Creek west and north of Artesia were developed similarly except that synthetic hydrographs were developed manually by methods in Chapter 21, Section 4, National Engineering Handbook.

A qualitative analysis was made to relate the water yield under present conditions and under future conditions with the proposed structural measures installed. Consideration was given to the effects of the structural

measures on surface runoff and to groundwater recharge. In brief, the analysis related (1) direct flow to the Pecos River, (2) evaporation, and (3) infiltration under present conditions to the same parameters under future conditions.

Hydrologic Design

Principal spillway capacities of floodwater retarding structures were calculated to meet the New Mexico State Engineer criteria. The principal spillway capacities also comply with the requirements of SCS Engineering Memorandum 27 dated March 19, 1965.

Minimum floodwater storage requirements were determined by the procedure outlined in the Soil Conservation Service Technical Release No. 10. The point rainfall amounts of storage determinations were adjusted for drainage area by the curves of Figure 10, U.S. Weather Bureau Technical Paper No. 49. The runoff was adjusted for channel transmission losses by the method in Chapter 21, Section 4, National Engineering Handbook, with these values modified according to the dominant hydrologic soil group occurring on the sub-watershed.

Emergency spillway and freeboard design inflow hydrographs were developed using the procedure outlined in National Engineering Handbook, Section 4, Chapter 21. Rainfall amounts were determined for appropriate structure classes for E. S. 1020, Section C, SCS Engineering Memorandum 27, Earth Dams, dated March 19, 1965, and adjusted for the drainage area size by humid, sub-humid climate curve, E. S. 1003, Engineering Memorandum 27.

The elevation of the settled top of the embankments was determined by flood-routing the freeboard hydrographs through the reservoirs and spillways beginning at the top of the level sediment pool or permanent pool. Routing the emergency spillway hydrographs through the structures, beginning at the top to the level sediment pool or permanent pool, was the basis for selection of the proper design and proportion of emergency spillway control sections. The storage indication method was used for flood routing through structures.

The areal rainfall factor and routing procedure for Site 19 was approved by the Engineering Division in Washington. The inflow emergency spillway hydrograph for Site 19 was developed from an areal rainfall distribution covering the entire drainage area above Site 19. Routings, in series, from this distribution control the proportions and hydraulic dimensions at Site 19, rather than the intervening and localized distribution. Individual hydrographs are routed through Sites 6 and 8, with this series areal distribution and combined with the hydrograph at Site 19 for the area intervening below Sites 6 and 8 with Sites 5, 14, and 15 considered ineffective. Sites 5, 14, and 15 are relatively small class "a" sites, having small drainage areas, low dam heights, and in close proximity of Site 19.

Design flow for floodwater diversions and outlet channels was developed using composite peak flows from structure outflow, where applicable, and flow from intermediate drainages. Flood routing through the Cottonwood improved channel section was accomplished by the convex method of channel flood routing described in Chapter 17, Section 4, National Engineering Handbook.

Water Budget Study

A water budget study was made on the recreation pool of the proposed multi-purpose reservoir at Site 19. The study is based on evaporation data from three stations in the area adjusted to Site 19 conditions, precipitation at Artesia, and low flow measurements on Cottonwood Creek.

The low flow measurements on Cottonwood Creek were made by Soil Conservation Service field office personnel at Artesia and personnel of the New Mexico State Engineer's Office at Roswell. This data represents only two years of records. It is recommended that measurements be continued so that any variance in data from a longer record may be incorporated into the design of the recreation site before actual construction begins.

Water Rights[1/]

Changes of points of diversion and the use of existing surface and ground water rights to a recreational purpose in Site 19 will need to be made pursuant to statutory and regulatory procedures. Permit for such changes is initiated by application to the State Engineer.

All surface and ground water rights in the Cottonwood Creek system have been adjudicated. There are no unappropriated surface or ground waters.

The project sponsors have indicated that the water rights on portions of sections 2, 3, and 4, T.16S., R.25E. can be acquired by transfer. A review of the State Engineer's records indicates there are 296 acres of ground water rights from three artesian wells, 225.3 acres of surface water rights from three diversions located upstream from Site 19 on Cottonwood Creek, and 64.7 acres of land having water rights from surface water and/or artesian ground water sources.

Evaporation losses from the storage pool (tentatively estimated as an average of about 6.1 acre-feet per year per acre of surface water area) must be offset by retirement of consumptive use depletions from irrigation without detriment to other existing rights. Likewise, the initial filling of the pool (and subsequent refilling if it becomes

1/ This section has been prepared with the assistance of the New Mexico State Engineer.

necessary) must be offset by a similar consumptive use depletion from irrigation rights. Filling may not be made from floodwater for such water is not available for appropriation.

Surface Water Right Transfers

The value of the surface water rights transferred to the pool is what would be depleted from the flows available for irrigation from the rights transferred. The remaining water must be passed through the dam. To determine the releases which must be made from the reservoir will require the establishment and operation of inflow and outflow continuous measuring devices constructed and maintained in a manner suitable to the State Engineer and at the expense of the sponsors.

Artesian Water Rights Transfer

Pumpage from any or all of the three artesian wells as they are now located on the Grindstaff property may not exceed the depletion rights of the acreage transferred.1/ This depletion right is tentatively estimated as 2.1 acre-feet per irrigated acre.

SEDIMENTATION AND RELATED INVESTIGATIONS

Field investigations pertaining to sediment and erosion problems in the watershed were made in accordance with prescribed Soil Conservation Service guidelines. Computation of yields and allocation of sediment storage was made in accordance with methods set forth in Soil Conservation Service Technical Release 12 and Engineering Memorandum SCS-16. Field studies included reconnaissance surveys of geology and physiography, slope percent and length, ground cover, and soils. Soil series were mapped on U.S. Geological Survey topographic sheets from the latest Soil Conservation Service soil maps.

Sediment damage to the irrigated lands was determined by interviews with the land operators concerned. This information was verified by spot checks on adjacent non-leveled tracts.

CHANNEL STABILITY INVESTIGATIONS

Reconnaissance examinations of stream channels and proposed principal spillway outlet channels and diversions were made to determine the intensity of investigation needed. The channel cross sections selected were surveyed, diversion centerlines were staked, and grade lines estimated. A total of 724 feet of drill holes, pits, and back hoe ditches were examined and sampled. Coarse-grained samples were sieved and grain-size distribution curves drafted. Selected fine-grained distributed samples were analyzed. Six undisturbed samples, hand-cut, were tested for saturated, unconfined compressive strength. The results of these analyses and tests were used in determination of channel stability for planning purposes. The tractive force and tractive power methods, as set forth in Soil Conservation Service

1/ This property now owned by the New Mexico State Park and Recreation Commission.

Technical Release 25, were used. Bedload transport analyses were made as outlined in South Technical Center Technical Guide 12.

GEOLOGIC INVESTIGATION

A preliminary site investigation was made at each proposed structure location in accordance with Engineering Memorandum SCS-33 (Rev.). Shallow bore holes, using a truck-mounted power auger, were drilled to determine possible location and volume of rock excavation and to field test for engineering properties of soils in emergency spillway control sections. Cutoff depths and the nature of the material in the foundations were estimated using geologic cross sections developed from well logs of 49 water and test wells. Surface geology and shallow drill holes (283 feet), as well as extensive geologic literature and maps developed in the course of groundwater studies by the United States Geological Survey, were also used.

In addition, detailed geologic investigations were conducted on Sites 13B, 17A, and 19. The following is a summary of intensity of investigation on the three sites:

Investigations	Site 13B	Site 17A	Site 19
No. of holes or pits	24	57	110
Total footage	187.5	1,141.0	2,352.0
Penetrometer testing	0	0	94
Permeability testing	1	3	239
No. of samples	4	41	48

Field permeater tests were run on typical Pecos River bottom land sites and one permeability test conducted in the laboratory on an undisturbed sample from the common bottom land. These tests were for the purpose of determining if an appreciable volume of water was lost by seepage during periods in which overbank floodwaters are ponded.

Most of the excavation will be common. Borrow material, consisting of Unified Soil Classification System CL, SC, SM, and ML, is available in adequate volume at all sites.

The above conditions have been taken into account in arriving at cost estimates and design of the proposed structures. Detailed investigations with suitable drilling and excavating equipment, as well as laboratory

and in-place field testing of materials, will be required prior to final design and construction.

Geologic Classification of Structure Sites

Geologic Formation	Age	Site Numbers
Older Alluvium	Quaternary	1, 3, 4, 5, 13B, 14, 15, 17A, and 19
Artesia Group	Permian	6, 7, and 8

RECREATION, FISH, AND WILDLIFE INVESTIGATION

Site 19 has been investigated by the New Mexico Department of Game and Fish, Soil Conservation Service biologists and recreation specialists, and by the U.S. Fish and Wildlife Service. The U.S. Fish and Wildlife Service made a report on the feasibility of Site 19 for development as a recreation site in June 1967. A portion of their report is included as follows:

"The Bureau of Sport Fisheries and Wildlife in cooperation with the New Mexico Department of Game and Fish has completed a reconnaissance study of the Cottonwood-Walnut Creek Watershed in Chaves and Eddy Counties, New Mexico. The project is sponsored by the Central Valley, Hagerman-Dexter, and Penasco Natural Resource Conservation Districts and the Cottonwood-Walnut Creek Watershed District.

This report was prepared in accordance with the provision of Section 12 of the Watershed Protection and Flood Prevention Act (68 Stat. 666, as amended; 16 USC 1008). It was concurred in by the New Mexico Department of Game and Fish as indicated by the enclosed copy of Director Ladd S. Gordon's letter dated June 19, 1967.

There is a scarcity of fishing water in the watershed and surrounding area. Lake McMillan, a large body of water located on the Pecos River about 15 miles southeast of Artesia, is subjected to extreme draw-downs; consequently, fishing is limited. Fishery management has been difficult because of shallow depths and periodic high turbidity of the reservoir. Non-game fish comprise the major percentage of the fish population in Lake McMillan. There is little fishing on the Pecos River in this area except in that section below Johnson Springs which is a short distance below McMillan Dam. Without the project, these conditions are not expected to change significantly.

Fishery management for game species would be less difficult and continued high use of the reservoir assured if the average depth of the permanent pool was about 10 feet. Increased depth could be accomplished through steepening of the shoreline so that it falls abruptly to 2 or 3 feet when

water is at spillway crest elevation and through increased dirt removal from the shallower areas of the reservoir basin or by raising the elevation of the permanent pool."

Field investigations were made in April and June 1971, jointly with biologists of the New Mexico Game and Fish Department and the United States Department of the Interior Fish and Wildlife Service. Determinations were made as to the effects of project structural measures on existing fish and wildlife values. Agreement was reached as to the extent of anticipated damages, and the amounts and types of measures that would be needed to restore the project area to pre-project conditions. Opportunities to create improved wildlife habitat conditions were developed and discussed with the sponsors.

Decisions were reached by the sponsors not to make wildlife habitat improvement a project purpose, or to request Public Law 566 cost-sharing for enhancement measures.

It is anticipated that many of those coming to the reservoir (Site 19) to fish and hunt will also use the camping and picnicking facilities that will be included in the basic recreational development at the site. The basic recreational facilities will have capacity for an additional estimated 44,600 visitors per year who do not come to the site to fish or hunt, but to use the camping and picnicking facilities only.

ECONOMIC INVESTIGATIONS

All known sources of information on flood damage were contacted, including farm operators and owners, railroad officials, and state and county road officials. Newspaper files were also consulted. Information was obtained for floods that occurred in 1915, 1937, 1941, 1954, 1960, 1962, 1964, 1965, 1966, and 1967.

Agricultural damage estimates were based on information contained in schedules obtained from farm owners and operators on about 95 percent of the agricultural units in the flood plain. These schedules covered land use, crop distribution, yields, historical data, and flood damage. They related to damage caused by floods in 1954, 1964, and 1965.

In the calculation of crop and pasture damage, expenses saved, such as the cost of harvesting and other production inputs, were deducted from the gross value of the damage. Flood plain land use was mapped in the field. Estimates of normal flood-free yields were based on data obtained from schedules supplemented by information from other agricultural workers in the area and from secondary sources. Crop yields for evaluation under future conditions reflect some increase over present yields because of anticipated improvement in technology and management.

The damageable value of crops and pasture grown in the watershed was determined from local data on cost returns for crops in the watershed area.

A crop damage factor for a composite acre was determined from the damageable value for the various crops grown in the floodplain. The composite acre damage factor reflected loss from reduction in crop yields, damage to quality of crops, increased production cost, increased maintenance cost, and other agricultural losses.

Application of the crop damage factor to acres flooded by depth increments, to all storms, within each evaluation reach, were obtained for both "with" and "without" project conditions. Resultant damages were converted to annual equivalents. The difference represents damage reduction benefits. No division was established between sediment and floodwater monetary damage.

Average annual crop and pasture damage was arrived at by using the "peak-discharge-area inundated relationship" developed in the hydrologic analysis. The analysis developed by the planning staff hydrologist includes storms or floods up to and including the one percent chance event. This analysis gave the area and depth of inundation for each size storm used in the evaluation.

A substantial degree of intensification of agricultural production is anticipated in the future. Although intensification benefits were not claimed for the project as such, it was necessary to establish the extent of this expected intensification and reflect it in the various aspects of the agricultural damage evaluation. As a result, damage appraisal on agricultural property reflects higher damageable values under future conditions than present conditions.

Other agricultural damage included areas that needed releveling, broken and/or clogged irrigation ditches, damaged fences, loss of livestock and fowl, and damaged irrigation borders. This damage appraisal was based on damage information from the floods of 1954, 1964, and 1965. The total damage was then divided by the acres flooded to arrive at an average value per acre. Average annual damage was then determined by measuring the area underneath the damage-frequency curve for each evaluation unit.

In order to allow for future increased urban damage values, a factor was applied to existing residential and commercial property and an adjusted factor for future growth after proper discounting to present worth. These factors are based on personal disposable income trends projected by the Office of Business Economics for the area in which the watershed is located (Upper Pecos Water and Resource Planning Area 1306).

Flood damage reduction benefits were determined as the difference between future damage without and with project. Physical damage was converted to monetary values and their reduction credited as project benefits. Average annual flood damage for future conditions and the average annual flood damage reduction benefits are shown in Table 5.

Evaluation of flood damage and flood damage reduction benefits in the watershed were made for Walnut Creek and for Cottonwood Creek. The two drainages and floodplains are separate and independent.

The tributary drainages west and north of Artesia are a part of the Cottonwood Creek Watershed. Flood runoff from these tributaries causes local flood damage in and north of Artesia before entering the Cottonwood Creek main channel. Since these tributaries usually bring flood runoff into the lower end of Cottonwood Creek ahead of flood runoff from the upper watershed, the water surface or flood level is raised or increased on the common floodplain.

Separation of estimated flood damage from historical floods on the common floodplain at the lower end of Cottonwood Creek is not considered feasible or practical. Likewise, when using the flood frequency analysis for flood routing, separation of tributary flood flows, and main stem flooding on the lower end of Cottonwood Creek, it is not considered practical.

The development of Site 19 for fishing and associated basic recreation facilities will result in approximately 63,970 annual recreational visits. The estimated 19,270 annual recreation visits for fishing and hunting would yield an annual benefit of $31,000. The estimated use for fishing and hunting was made by the New Mexico Department of Game and Fish in their evaluation of the project for recreation. The use of the basic recreational facilities for picnicking, camping, and boating would provide an additional 44,700 annual recreation visits and $67,100 annual benefits.

Redevelopment benefits represent the value of annual wages paid to otherwise underemployed or unemployed local labor used in the installation, operation, and maintenance of the project.

The watershed lies partly in Chaves County, which is in the Four Corners region, and partly in Eddy County, which is included in an area designated by the Public Works and Economic Development Act of 1965 as being an area of chronic unemployment and underemployment.

When a watershed is in an area so designated, the evaluations of redevelopment benefits are based on:

1. Wage rates to local labor during construction are to be 30 percent of the estimated construction costs.

2. Value of annual wages paid to local labor is to be 50 percent of the estimated annual operation and maintenance costs.

3. Benefits from operation and maintenance are to be evaluated on a decreasing scale for a 25-year period.

In this project, redevelopment benefits evaluated from the employment of local labor for project installation, which would otherwise be underemployed or unemployed, would average $134,000 annually. This is based on 30 percent of estimated construction costs, or $2,273,100, and amortized at 5-7/8 percent interest over 100 years.

Likewise, benefits were also evaluated from the employment of labor to operate and maintain the project that would otherwise be unemployed or underemployed. These benefits have been evaluated only on the first 25 years of the project period, and on an annual operation and maintenance cost of $61,700.1/ Redevelopment benefits from operation and maintenance average $14,700 annually over the life of the project. Total redevelopment benefits are estimated to be $148,700 annually.

Secondary benefits are those "stemming from" or arising from the increased production of goods and services as a result of the project. They also include benefits "induced" by the project. These induced benefits are increased expenditures by people in the area as a result of the project.

They are estimated to be 10 percent of direct damage reduction benefits, recreation benefits, and annual O&M costs excluding replacement, fish stocking, and pumping costs. The total of these three items on which secondary benefits were based amounted to $576,1001/ annually. This resulted in $57,700 average annual secondary benefits.

From a national viewpoint secondary benefits were not considered pertinent to the economic evaluation. At the local level they were significant but were not used for project justification.

1/ Excluding $19,300 for the cost of fish, replacing basic facilities, and pumping water for recreational pool.

APPENDIX A

RECENT ANALYSES OF SURFACE AND GROUND WATER IN AND NEAR SITE 19 - COTTONWOOD CREEK 1/

	Source 1 Cottonwood Creek ¼ mile west of proposed Site 19 dam site. Upstream 300 gal/min	Source 2 Deep Artesian Well RA #1008-1008S 3/4 mile west of proposed Site 19 dam site. 1800 gpm	Source 3 Shallow Artesian Well RA #15114 1 mile NE of proposed Site 19 dam site. 540 gpm
P. H.	8.5	8.0	8.0
Alkalinity:			
a. Phenophthalein	0	0	0
b. Methyl Orange all bicarbonates	171 ppm	205 ppm	153 ppm
Total Hardness (as CaCO3)	1060	1179	2070
Dissolved oxygen	-	-	11 ppm

1/ May 1975 - Field Analyses by Soil Conservation Service personnel.

June 1975

APPENDIX B

CHEMICAL ANALYSES OF GROUND WATER FROM QUATERNARY ALLUVIUM AND SAN ANDRES LIMESTONE[1/]

Well Location (T.16S.,R.25E)	Water-bearing Formation	Date Collected	Temperature (°F.)	Chloride (Cl)	Specific Conductance (micromhos @25°C.)
Sec. 3	San Andres and Grayburg	5/21/28	66	20	-
		2/8/39	-	15	2,040
Sec. 5	Grayburg	8/11/58	71	17	1,780
		9/9/58	72	15	1,790
		3/3/59	70	15	1,770
Sec. 6	Alluvium	2/8/39	-	139	2,310
Sec. 8	Alluvium	4/30/57	-	16	1,150
Sec. 11	Alluvium	2/8/39	-	62	2,540
Sec. 11	Alluvium	2/11/44	-	15	979
Sec. 11	Alluvium	9/1/55	65	53	2,440
Sec. 11	Alluvium	9/9/58	65	55	2,650
		1/20/59	65	70	2,560
		3/3/59	66	54	2,370
Sec. 15	Alluvium	4/30/57	63	134	3,330

1/ Hood, J. W., 1963, Saline Ground Water in the Roswell Basin, Chaves and Eddy Counties, New Mexico, 1958-1959; Geol. Survey Water Supply Paper 1539-M, U.S. Geol. Survey.

June 1975

APPENDIX C

CHEMICAL ANALYSES OF GROUND WATER FROM SAN ANDRES LIMESTONE IN SEC. 5 - T.16S. - R.25E. 1/

Well Location	Date of Collection	Chloride (Cl) (Mg/L)	Temperature	Specific Conductance	Ph
T. 16S. - R. 25E., Sec. 5	8/21/69	16	-	1790	-
San Andres	8/7/68	11	21°C.	1810	6.9
	8/3/66	22	71°F.	1710	-

1/: U.S.G.S., Water Resources Data for New Mexico, Pt. 2, Water Quality Records.

June 1975

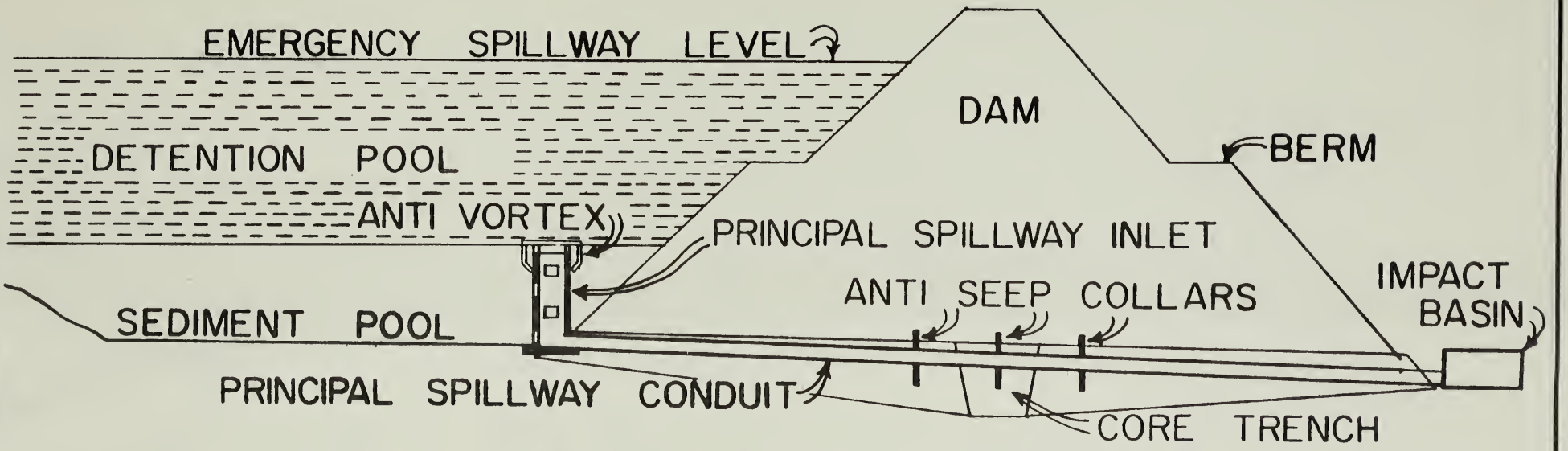

FIGURE 1

SECTION OF A TYPICAL

FLOODWATER RETARDING STRUCTURE

FIGURE 2

SCHEMATIC DRAWING OF PROPOSED
RECREATIONAL DEVELOPMENT
SITE 19
COTTONWOOD-WALNUT CREEK WATERSHED
EDDY & CHAVES COUNTIES, NEW MEXICO

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date		
Designed E.S. - NMSP&RC	3-74	Approved by	
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SCS-ENG-313-B Rev. 7-69

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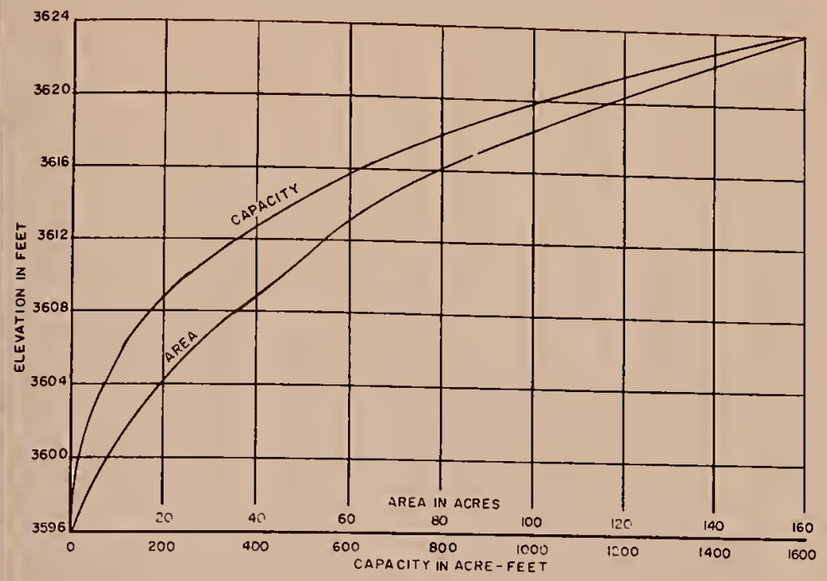

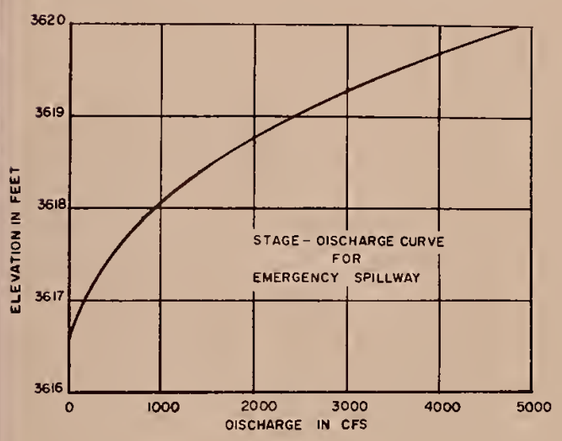

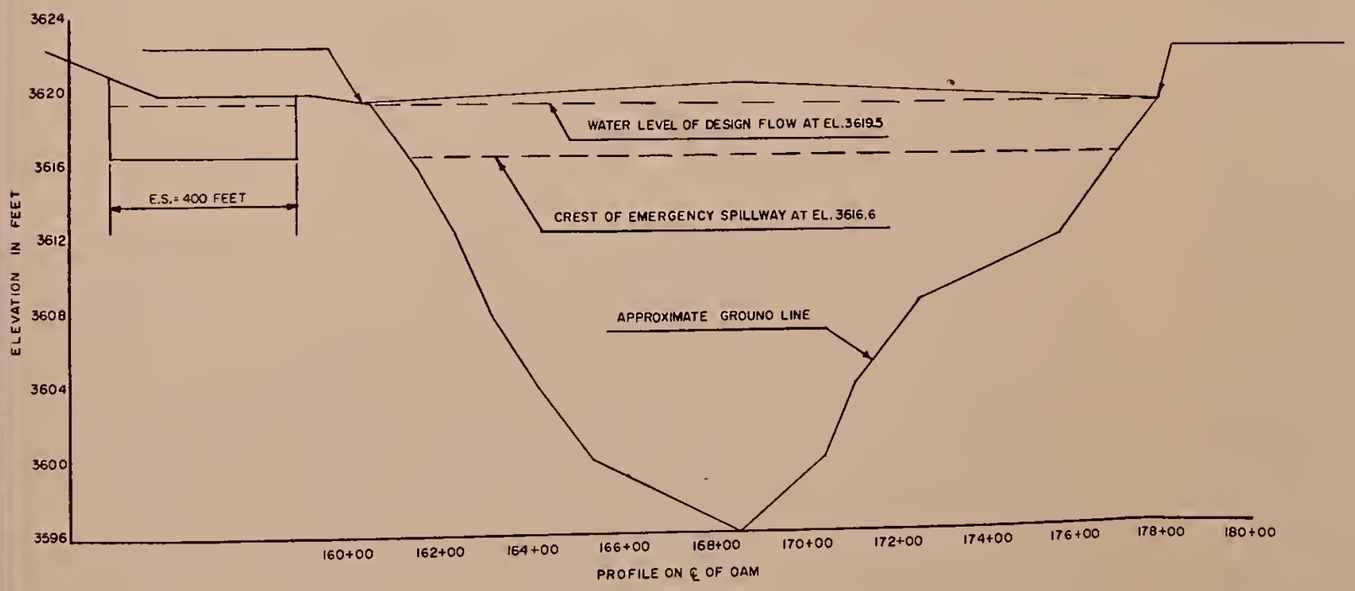

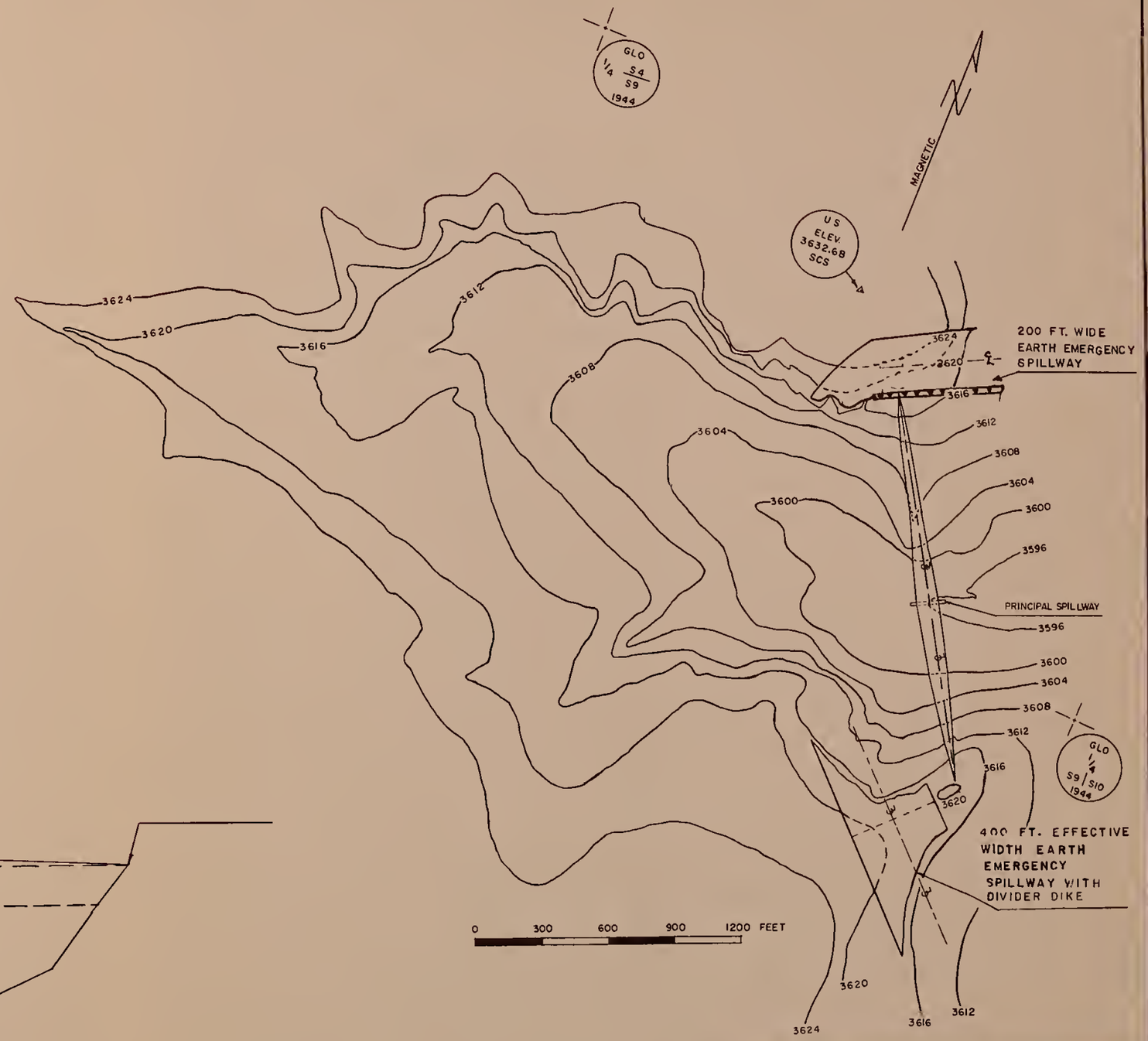

FIG. 3

TYPICAL FLOODWATER RETARDING STRUCTURE
WITH EARTH EMERGENCY SPILLWAYS
COTTONWOOD-WALNUT CREEK WATERSHED
EDDY & CHAVES COUNTIES, NEW MEXICO

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date		
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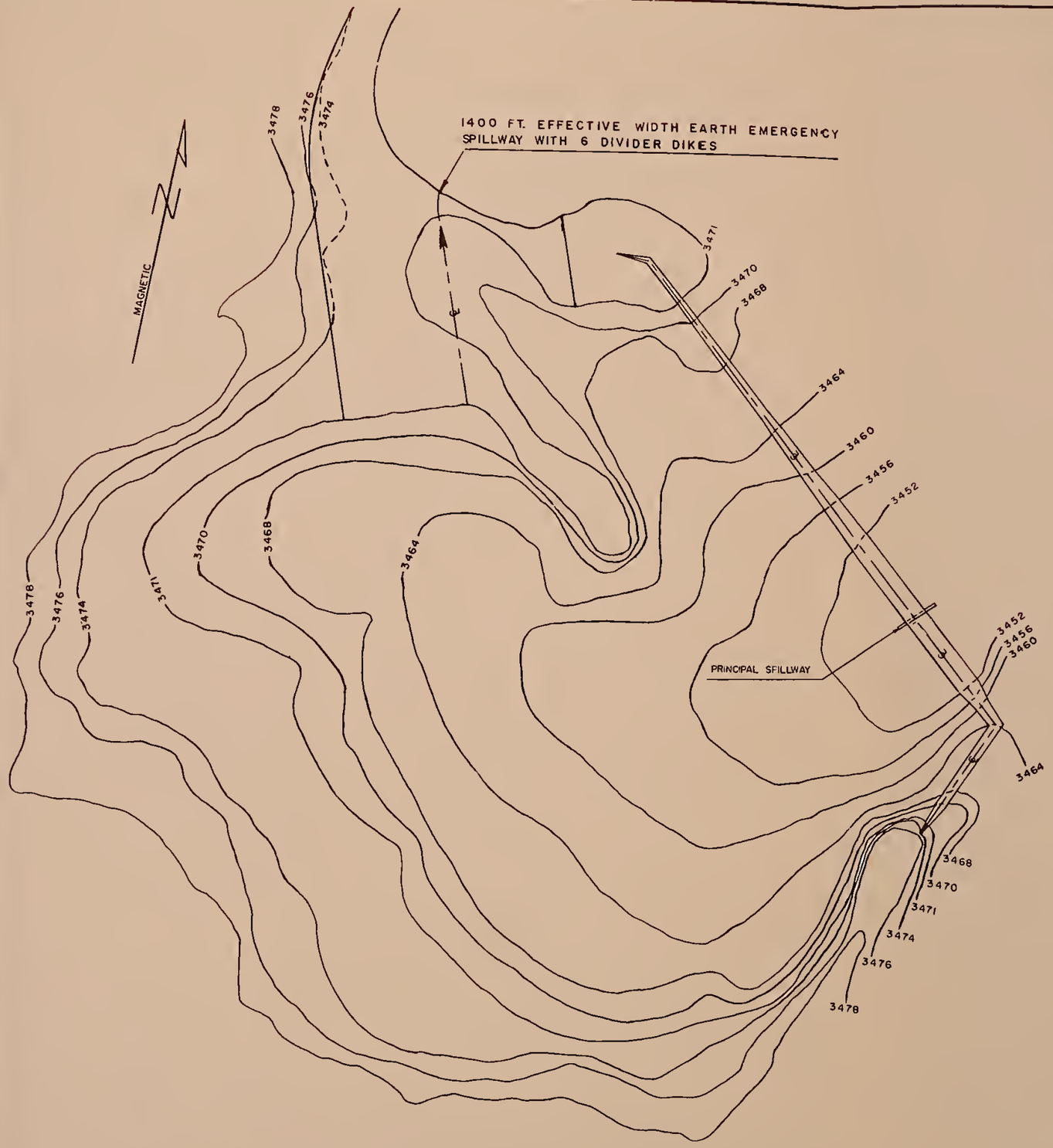
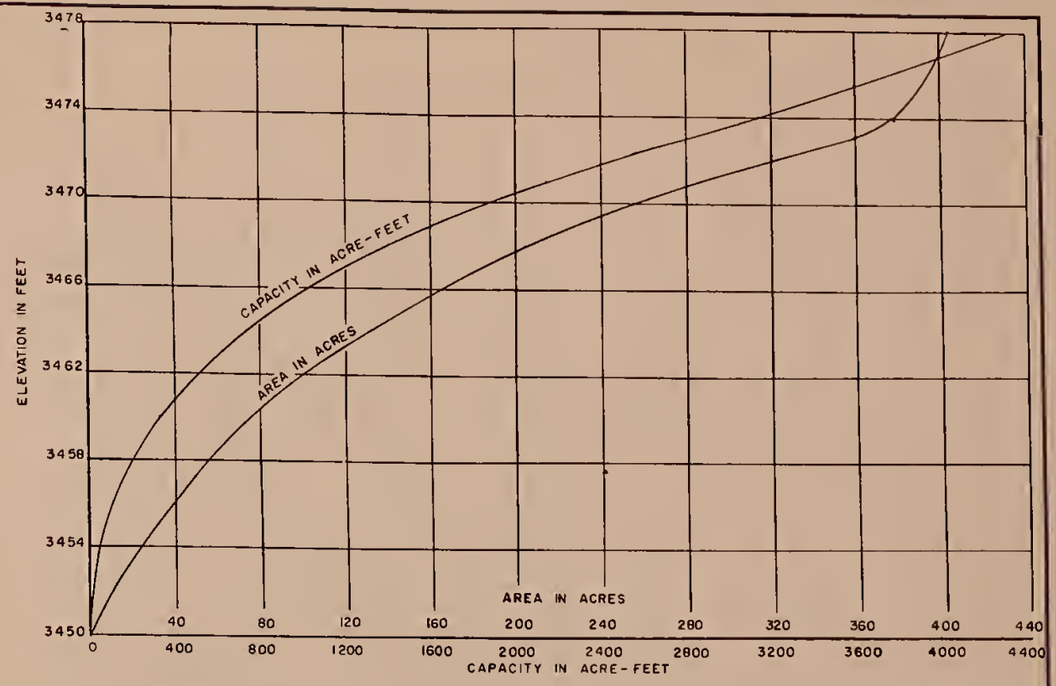
SCS-313B (APRIL 1963)





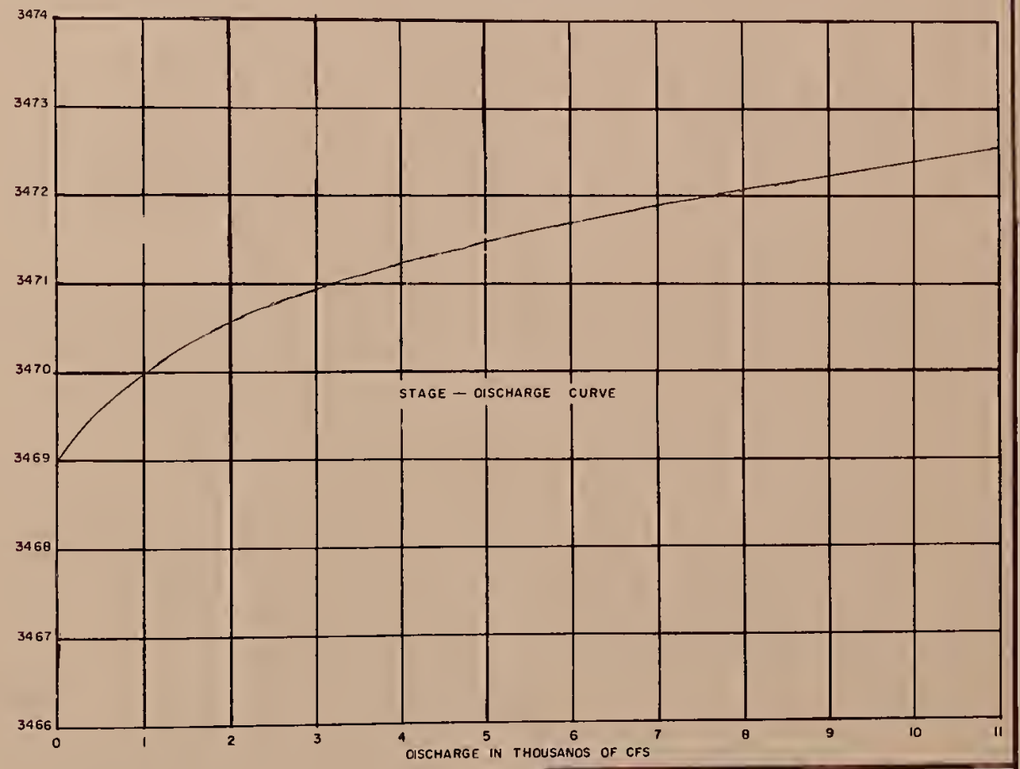


FIG. 4

TYPICAL FLOODWATER RETARDING STRUCTURE
WITH EARTH EMERGENCY SPILLWAY
COTTONWOOD-WALNUT CREEK WATERSHED
EDDY & CHAVES COUNTIES, NEW MEXICO

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Date		Approved by	
Designed	WHE & RDA	Title	
Drawn	BPE	Title	
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Checked	WHE & RDA		

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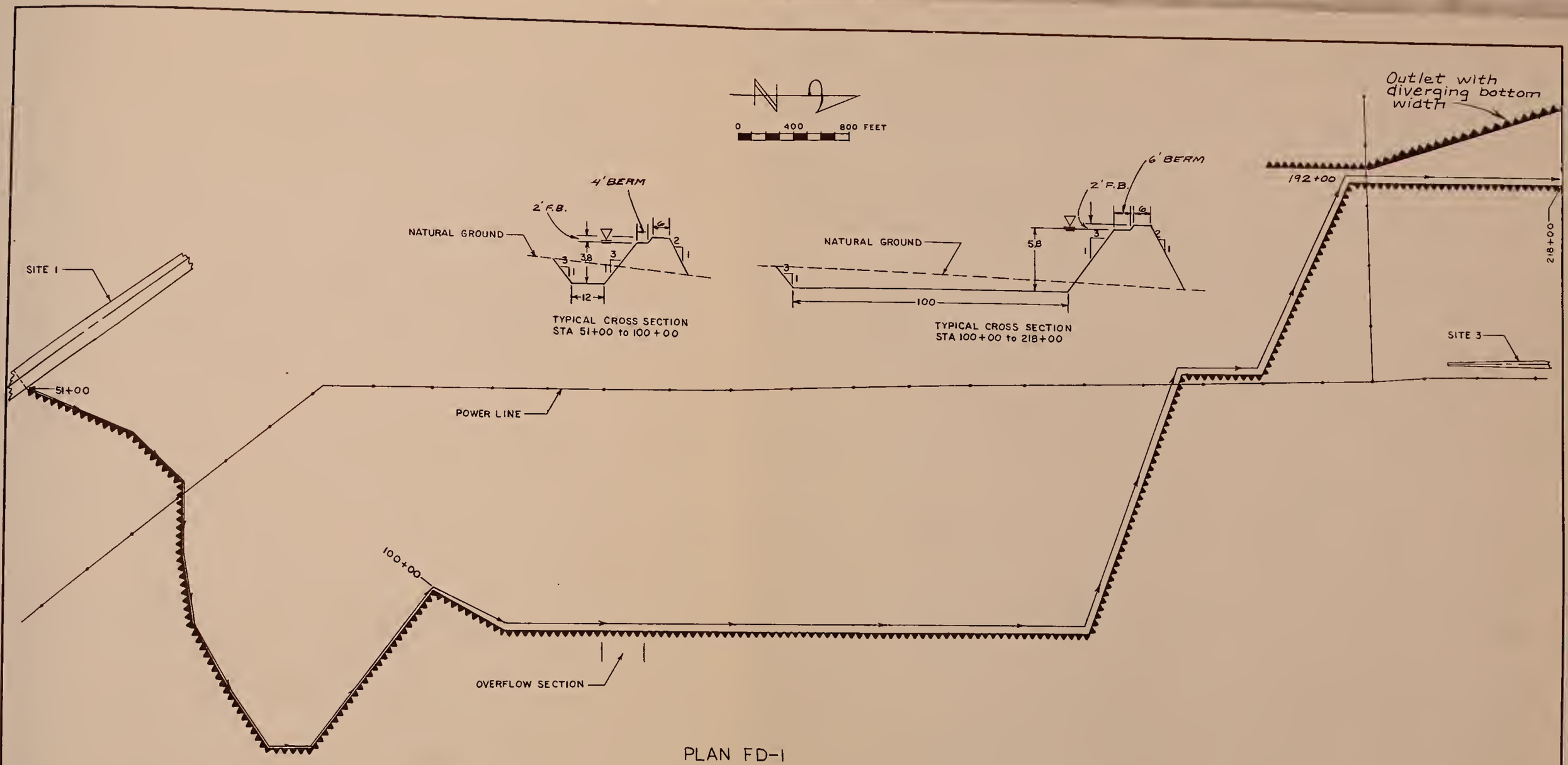
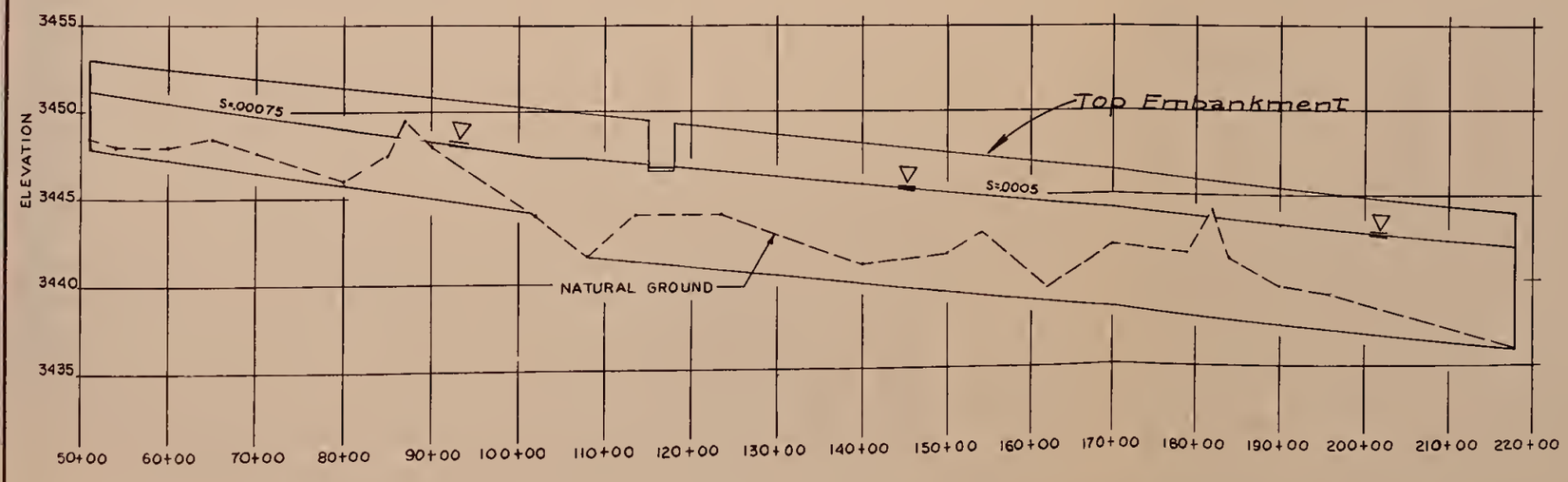


PLAN FD-1



PROFILE FD-1

FIG. 5

TYPICAL FLOODWATER DIVERSION
COTTONWOOD-WALNUT CREEK WATERSHED
EDDY & CHAVES COUNTIES, NEW MEXICO

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date		
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Drawn R. Anderson	6/68	Title	
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Checked		Sheet No. of	Drawing No

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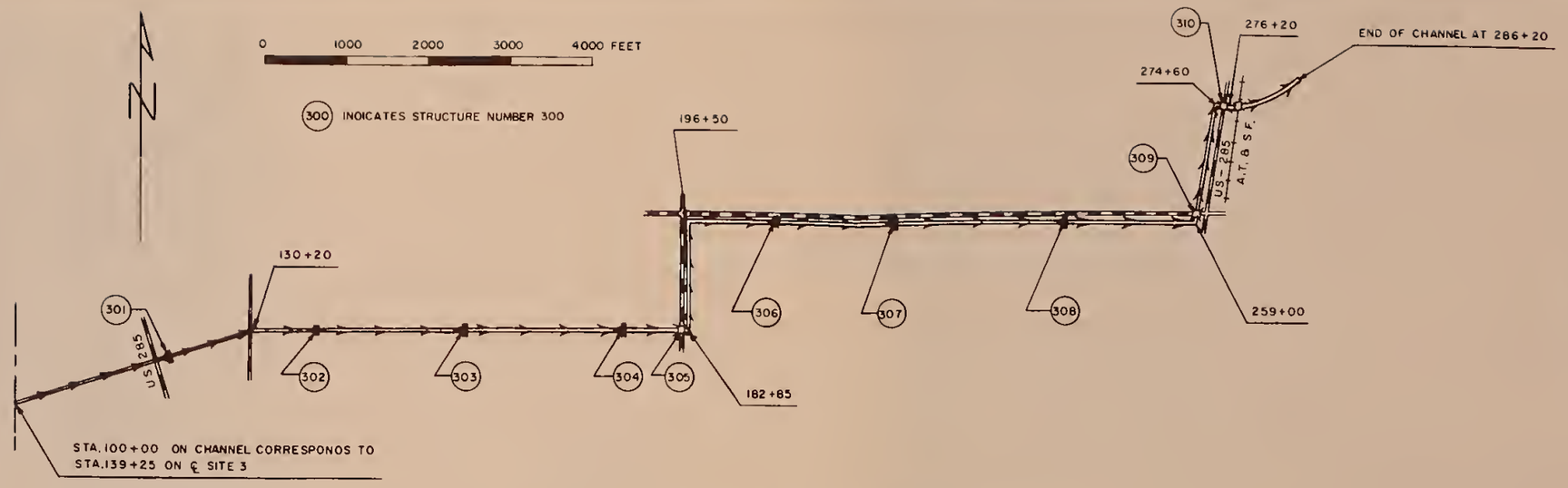
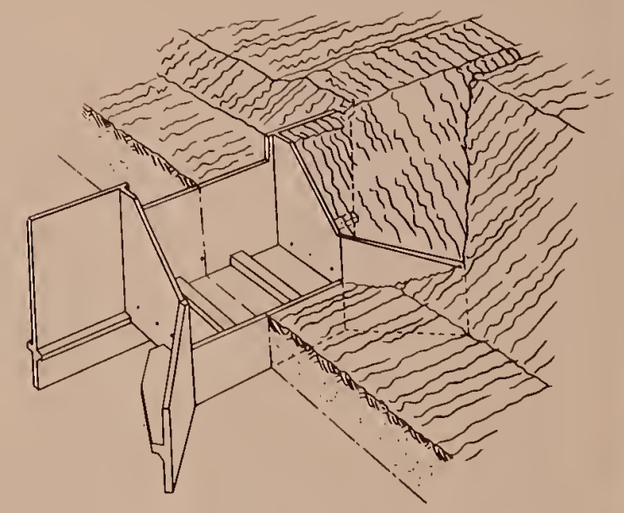
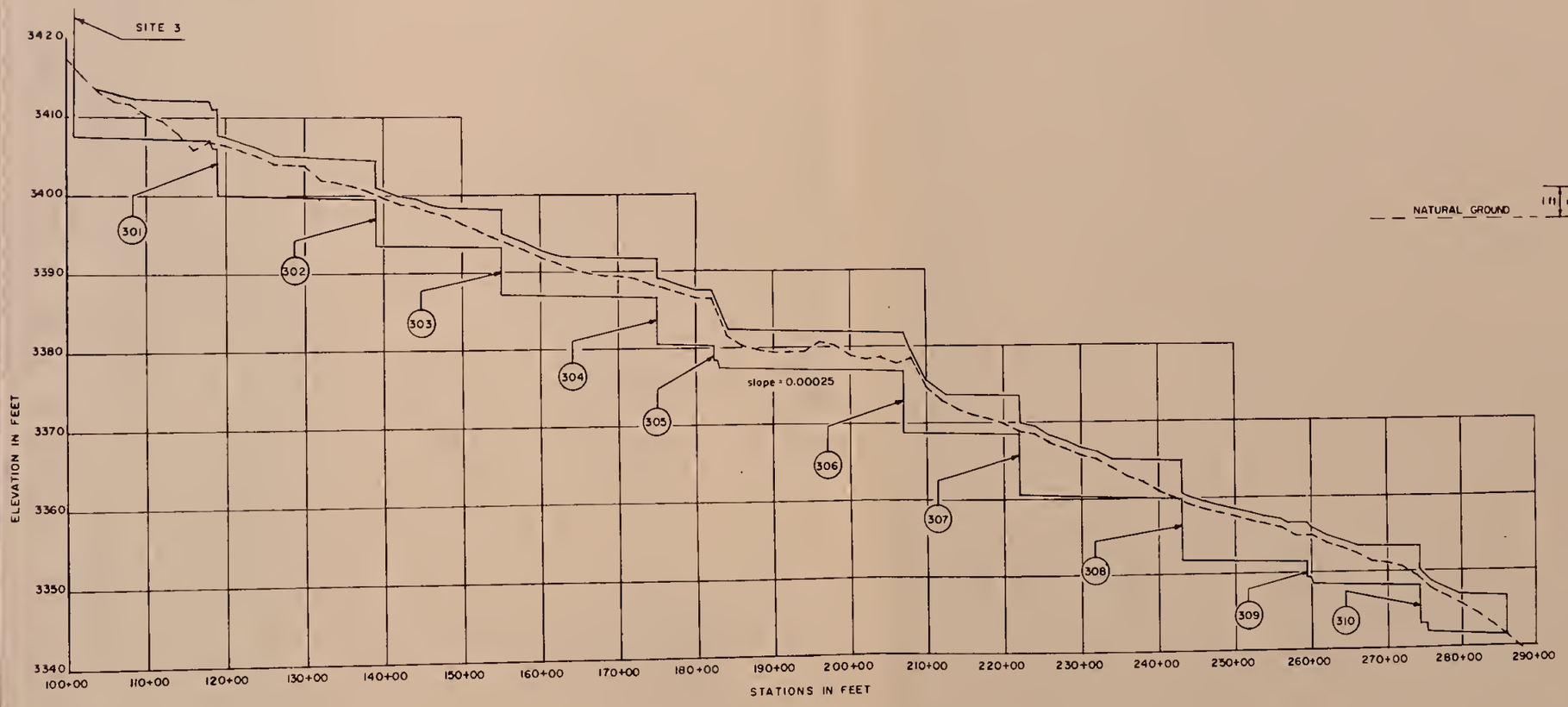


PLAN VIEW — CHANNEL 300

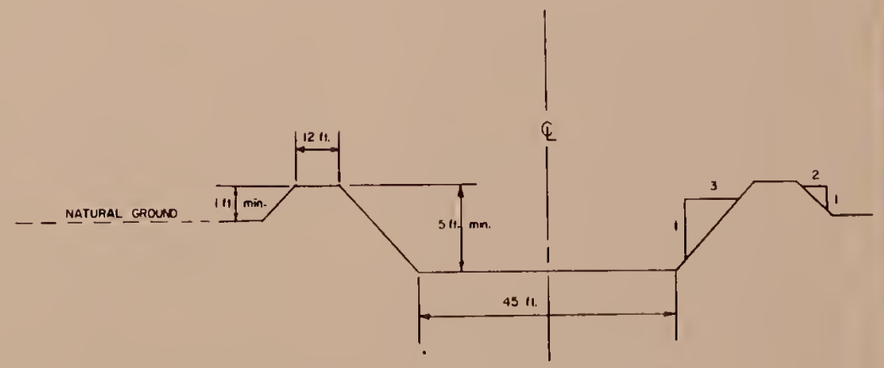


PERSPECTIVE VIEW OF DROP STRUCTURE

(NOT TO SCALE)



PROFILE VIEW — CHANNEL 300



TYPICAL CROSS-SECTION

FIG. 6

TYPICAL CHANNEL

COTTONWOOD-WALNUT CREEK WATERSHED

EDDY & CHAVES COUNTIES, NEW MEXICO

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date		
Designed WHE & ROA		Approved by	
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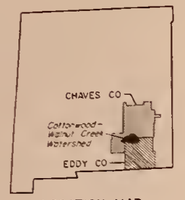
Checked WHE & ROA		Sheet No. of	Drawing No

U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE, ALBUQUERQUE, NEW MEXICO



LOCATION MAP

LEGEND

- Federal Highway
- State Highway
- County Line
- Railroad
- Drainage
- City or Town
- Watershed Boundary
- Channel Work
- F.D.I. Floodwater Diversion
- Recreation Development
- Area Benefited
- Area Benefited and Controlled
- Area Controlled by Structure
- Floodwater Retarding Structure
- Multiple Purpose Structure
- (6) Site Number
- D.A.-D.00 Drainage Area (Square Miles)

PROJECT MAP

COTTONWOOD – WALNUT CREEK WATERSHED

CHAVES & EDDY COUNTIES, NEW MEXICO

AUGUST 1974

1 0 1 2 3 4 5 MILES

APPROX. SCALE 1:126,720

Projection Unknown

SEPTEMBER 1974 4-R-33981

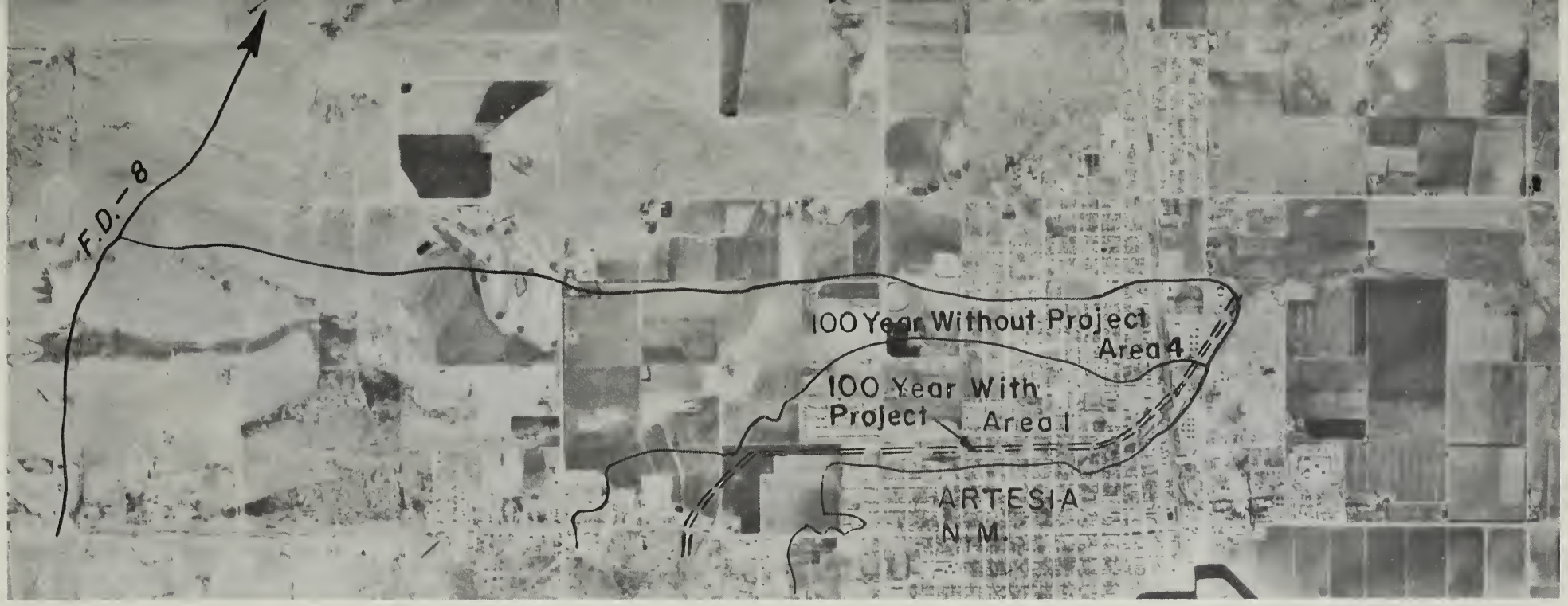


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FIGURE 7

COTTONWOOD-WALNUT CREEK WATERSHED

EDDY & CHAVES COUNTIES, NEW MEXICO

JANUARY 1971

½ 0 ½ 1 MILE

SCALE 1:31680